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Golden Anniversary Issue

AMERICAN FOUNDRYMEN'S ASSOCIATION

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CONTENTS

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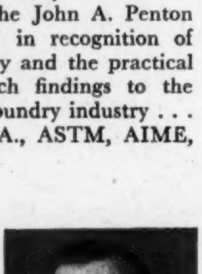
★ APRIL WHO'S WHO ★

J. W. Bolton

Nationally known figure in connection with foundry metallurgy and research, Mr. Bolton presents *"50 Years of Progress in Cast Metal Specifications"* . . . Is chief metallurgist, The Lunkenheimer Co., Cincinnati . . . Received his Bachelor of Science degree from Rose Polytechnic Institute, Terre Haute, Ind., in 1918 . . . Obtained his Master of Science degree in 1921 and four years later (1925) had conferred upon him the honorary degree of chemical engineer, both degrees from Rose Polytechnic Institute . . . Has served as chemist for Proctor & Gamble Co., Kansas City, Kansas, and Cincinnati . . . Was metallurgist with Niles-Bement-Pond Co., Hamilton, Ohio, and Frank Foundries Corp., Moline, Ill. . . . His work in connection with A.F.A. has embraced both gray iron and non-ferrous investigations and numerous papers and committee reports have been presented under his direction . . . He was the author of the A.F.A. exchange paper for the 1925 meeting of the Belgian Foundrymen's Association . . . Also prepared the exchange paper for the Institute of British Foundrymen in 1929 . . . Is author of the book *"Gray Cast Iron"* . . . Was presented the John A. Penton Gold Medal in 1937 in recognition of his work in metallurgy and the practical application of research findings to the advancement of the foundry industry . . . Is a member of A.F.A., ASTM, AIME, and ASM.



L. W. Eastwood

Current paper herein, *"Microporosity in Magnesium Alloy Castings"* . . . Authored by Mr. Eastwood and J. A. Davis . . . Mr. Eastwood was born in Wiota, Wis. . . . Attended University of Wisconsin, Madison, Wis., and received his Bachelor of Science degree in metallurgy, 1929 . . . Obtained his Master of Science degree, 1930, and Ph.D. one year later . . . Appointed assistant professor at Michigan College of Mines, Houghton, Mich., 1931-1935 . . . Became affiliated with Aluminum Co. of America, Cleveland, in 1935 as research metallurgist . . . Vice President of the Maryland Sanitary Mfg. Corp., Baltimore, 1942 . . . Present position, assistant supervisor at Battelle Memorial Institute, Columbus, Ohio . . . Has written extensively for the trade press and meetings of technical societies on physical metallurgy and non-ferrous foundry practices . . . Author of *"Introduction to Metallography"* published in 1931 . . . A member of A.F.A., AIME, ASM, and Institute of Metals (British).

J. A. Davis

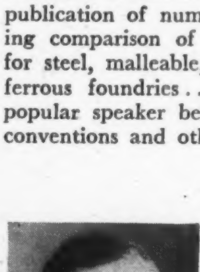
Co-author (with L. W. Eastwood) of *"Microporosity in Magnesium Alloy Castings"* . . . Mr. Davis was born in Ada, Ohio . . . A graduate of Colorado School of Mines, 1939 . . . Appointed as metallurgist, Colorado Fuel & Iron Co., Pueblo, Colo., and was associated with this firm until 1943 . . . At present is a member of the engineering staff, Battelle Memorial Institute, Columbus, Ohio . . . Has prepared a number of magnesium papers for AMERICAN FOUNDRYMAN in conjunction with fellow colleagues from Battelle . . . A member of ASM.

Committee Report

The Committee on Die Castings, Aluminum and Magnesium Division, A.F.A., has prepared and published in this issue, their annual report, *"Aluminum Alloy Die Casting"* . . . Organized in 1943, this committee has as one of its purposes to prepare data for recommended practices for aluminum, magnesium and zinc alloys . . . Committee members who aided in producing this report are: Chairman, J. C. Fox, Doehler-Jarvis Corp., New York; D. Basch, General Electric Co., Schenectady, N. Y.; E. J. Basch and G. F. Hodgson, Doehler-Jarvis Corp.; C. H. Mahoney, River Forest, Ill.; W. E. Martin, National Smelting Co., Cleveland; C. E. Nelson, Dow Chemical Co., Midland, Mich.; S. U. Siena, Sperry Gyroscope, Inc., Great Neck, Long Island, N. Y.; and R. E. Ward, Eclipse Pioneer Div., Bendix Aviation Corp., Bendix, N. J.

Ralph L. Lee

The question of *"Cost Per Piece—Cost Per Pound—Which?"* is raised in this issue by Ralph L. Lee . . . Associated with Grede Foundries, Inc., Milwaukee, as comptroller, Mr. Lee has long been active in the study of foundry costs . . . Born on a farm near Macon, Ill., in 1890 . . . Early schooling in Decatur, Ill., and studied law there at James Millikin University . . . Later studied accounting in Chicago . . . First position, assistant purchasing agent, Mueller Co., Decatur . . . Connected with a number of national organizations in various capacities . . . From 1917-20, held position of office manager, Wagner Malleable Iron Co., Decatur . . . Became secretary-treasurer at Liberty Foundry Co., Milwaukee, in 1920, where he served for 20 years . . . When Liberty merged with Grede in 1940, appointed to present position . . . Since 1935 has served as Chairman, A.F.A. Foundry Cost Committee . . . Also served on Cost Committee of Gray Iron Founders Society . . . Has participated in activities of A.F.A. Cost Committee in publication of numerous studies, including comparison of foundry cost factors for steel, malleable, gray iron and non-ferrous foundries . . . Is a frequent and popular speaker before A.F.A. chapters, conventions and other gatherings.



A. J. Herzig

Native of Toledo, Ohio, where he received his early schooling and first position, following graduation from college . . . Mr. Herzig attended the University of Michigan, Ann Arbor, and earned his Bachelor of Science degree in chemical engineering in 1926 . . . Became associated with National Supply

East Eng.
Chem Eng.
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Co., Toledo, as laboratory assistant, the same year . . . Two years later returned to the University of Michigan, Department of Engineering Research, as investigator . . . Remained at the university until 1931, at which time he was awarded his Master's Degree in engineering . . . That same year joined the staff of the Climax Molybdenum Co., Detroit, as metallurgist . . . Contributed to the 1939 A.F.A. convention as co-author of a paper on gray cast iron . . . A member of A.F.A., Mr. Herzig is author of *"Cast Iron . . . Modulus of Elasticity,"* which appears in this issue . . . Also a member of AIME, ASST, and SAE.

R. A. Harrington

In this issue Mr. Harrington, author of numerous papers on sand control, presents a discussion of *"50 Years of Progress in Foundry Sand Control"* . . . A graduate of Tufts College, Medford, Mass., he graduated in 1913 with a Bachelor of Science degree . . . Has been associated with Hunt-Spiller Mfg. Corp., Boston, for over twenty years . . . Held the positions of chemist in charge of laboratory and metallurgist in charge of metallurgical operations . . . In 1938 assumed his present position as foundry superintendent . . . Mr. Harrington has been active in association affairs for a number of years serving on a number of sand committees . . . He was a National A.F.A. Director 1933-35 . . . Holds membership in A.F.A., ASTM, AIME, and Past President New England Foundrymen's Association.

R. E. Lyons

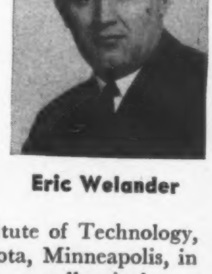
Co-author, with C. L. Frear, of *"Nondestructive Inspection of Castings"* . . . Born in East Orange, N. J. . . . A graduate of Newark College of Engineering, Newark, N. J., receiving his Bachelor of Science degree in mechanical engineering . . . First engineering position, following graduation from college, was with Revolator Co., North Bergen, N. J., as draftsman . . . Was named inspector of naval material, Philadelphia, being assigned to foundries inspecting castings . . . At present is in the Navy Department, Bureau of Ships, Washington, D. C., performing detailed work concerning casting and nondestructive testing.

J. E. Goss

Author of *"50 Years of Progress in Foundry Apprentice Training"* . . . Mr. Goss is a native of Fall River, Mass., where he received his early schooling . . . Has taken extension courses from Brown University, Providence, R. I. . . . Served his apprenticeship in drafting at Corliss Steam Engine Works, Providence, R. I. . . . Became draftsman for Taunton Locomotive Co. . . . Was instructor of mechanical drawing for five years at Fall River High School . . . Served as supervisor of apprentices, Brown & Sharpe Mfg. Co., Providence . . . Present position being industrial activities administrator . . . Has written extensively for the trade press concerning apprenticeship and has talked before a number of technical societies upon the same subject . . . A member of the Providence Engineering Society.

C. J. Converse

Author of the current article *"Sand Control in the Bronze Foundry"* . . . Mr. Converse was born in Stafford Springs, Conn. . . . His elementary education was enhanced by correspondence courses in mechanical engineering and industrial management . . . Began his industrial career in 1910 as a clerk in the machine shop, Wells Bros. (now Greenfield Tap & Die Corp.), Greenfield, Mass. . . . In 1912 joined Indian Motorcycle Co., Springfield, Mass., and learned general machine shop practice . . . Became associated with Bullard Machine Tool Co., Bridgeport, Conn., in 1915 as a tool designer . . . Two years later (1917) was appointed assistant to chief engineer, Liberty Ordnance Co., Bridgeport, Conn. . . . From 1918-21 was affiliated with Producto Machine Co., formerly Bilton Machine Tool Co., Bridgeport, Conn., as automatic and special machine designer . . . For eight years, 1921-28, was equipment designer and gage engineer, Crane Co., Bridgeport, Conn. . . . Was transferred to Crane's Montreal, Que., plant in 1928 and was named plant superintendent . . . A member of A.F.A.



Eric Welander

Mr. Welander, whose article on *"Malleable Iron Foundry Core Practice"* appears in this magazine, is plant metallurgist with Union Malleable Iron Works of Deere & Co., East Moline, Ill. . . . Born in Moline, Ill. . . . Received his degree from the Institute of Technology, University of Minnesota, Minneapolis, in 1938 . . . Entered the metallurgical profession upon graduation and became affiliated with Deere & Co., Moline, Ill., in their testing and research laboratories . . . Was transferred to the Union Malleable Iron Works in 1942 and was placed in charge of the chemical laboratory . . . A year later was named plant metallurgist, his present position . . . A member of A.F.A. and the Society for Quality Control.

C. L. Frear

Senior Materials Engineer, Bureau of Ships, U. S. Navy, Washington, D. C. . . . Mr. Frear is co-author with Robert E. Lyons of paper *"Nondestructive Inspection of Castings"* . . . A graduate of Syracuse University, Syracuse, N. Y., and Queens University, Kingston, Ont., Canada . . . Was instructor of chemistry at Lehigh University, Bethlehem, Pa. . . . Appointed assistant professor of materials and metals, U. S. Naval Academy Post Graduate School, Annapolis, Md. . . . Served as chief metallurgist, DeLaval Separator Co., Poughkeepsie, N. Y. . . . Was also connected with Kelsey-Hayes Wheel Co., Detroit, as metallurgical engineer . . . A contributor to past A.F.A. conventions, his papers have dealt with nondestructive inspection . . . An A.F.A. member.

Committee Report

From the Subcommittee on Physical Properties of Iron Foundry Molding Materials at Elevated Temperatures, formerly known as the Subcommittee on Physical Properties of Gray Iron Molding Materials at Elevated Temperatures, A.F.A. Foundry Sand Research Project, comes the report *"Gray Iron Foundry Sands"* . . . Meeting at least four times a year at the University of Michigan's foundry, Ann Arbor, these men have been busily engaged in developing a test method whereby the shakeout effort required to remove cores from castings could be measured by a quick laboratory test . . . Donning work clothes and performing as molders and pourers, the following committee members have continued their search for more complete test results which will be summarized and published in future issues of AMERICAN FOUNDRYMAN: Chairman, H. W. Dietert, Harry W. Dietert Co., Detroit; Vice-Chairman, George Watson, American Brake Shoe Co., Mahwah, N. J.; Secretary, William Spindler, University of Michigan; D. E. Cutler, J. S. McCormick Co., Pittsburgh, Pa.; Robert Doelman, Harry W. Dietert Co., Detroit; J. A. Gitzen, Delta Oil Products Co., Milwaukee; John Grennan, University of Michigan; H. G. McMurry, General Motors Overseas Div.; E. C. Olsen, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.; Emile Pragoff, Jr., Hercules Powder Co., Wilmington, Del.; Dr. H. Ries, Ithaca, N. Y.; Victor Rovell, Velsicol Corp., Chicago; Arnold Satz, National Radiator Co., Johnstown, Pa.; J. Schumacher, Hill & Griffith Co., Cincinnati; Wm. Seese, J. S. McCormick Co., Pittsburgh, Pa.; Leon B. Thomas, Wilson Foundry & Machine Co., Pontiac, Mich.; W. B. Timm, Bureau of Mines, Ottawa, Ont., Canada; R. D. Walter, Werner G. Smith Co., Cleveland; D. C. Williams, Cornell University, Ithaca, N. Y.; and E. C. Zirzow, National Malleable & Steel Castings Co.

TO MORE SCIENTIFICALLY SERVE THE FOUNDRY INDUSTRY

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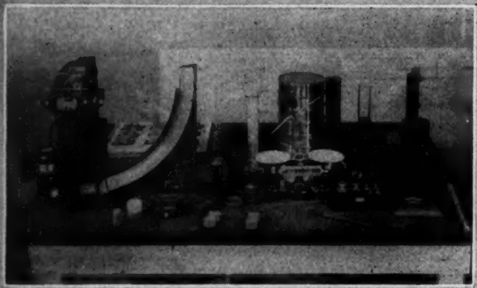

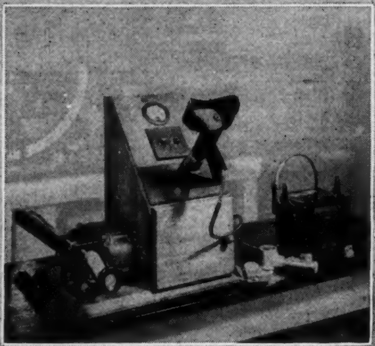

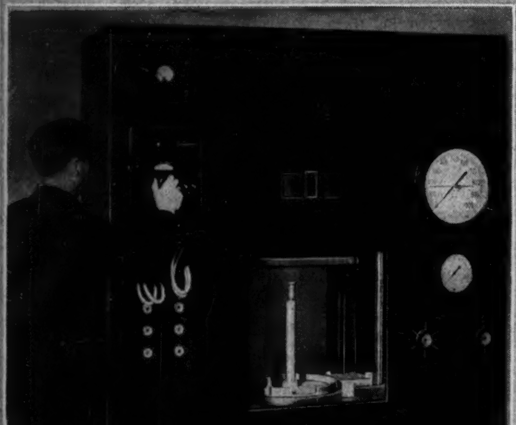

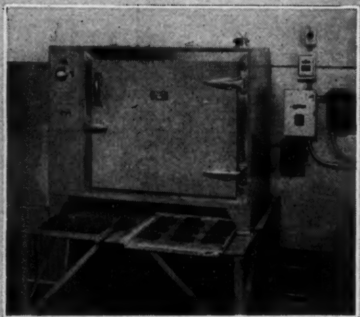

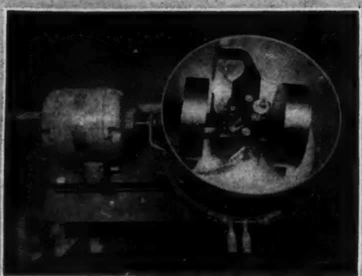

Scientific Labor

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EVERY DELTA FOUNDRY PRODUCT IS SCIENTIFICALLY DEVELOPED TO DO A PARTICULAR JOB ... BETTER

Extensive laboratory facilities are devoted to research and development of DELTA Foundry Products. Modern scientific apparatus and equipment ... every requirement of a completely equipped foundry laboratory ... play a vital part in a continuing program of product development and standardization.

Every foundry product conceived and developed in DELTA Research Laboratories is first tested and passed in laboratory technique. It is then submitted for use and final approval in actual foundry practice before it is identified with the name "DELTA".

Every step in the manufacture of DELTA Foundry Products is supervised by skilled technicians of the DELTA chemical staff. All physical, mechanical and scientific factors are coordinated to safeguard quality and insure absolute uniformity in the finished product.

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PRESIDENT WALLS HONORS MEN WHO FIRST VISUALIZED AN A.F.A.

WITH THE OPENING of the Golden Anniversary Convention, May 6 at Cleveland, we will commemorate the adventure of a group of foundrymen inspired by Howard Evans, then Secretary of the Philadelphia Foundrymen's Association and encouraged by John A. Penton, at that time publisher of *The Foundry,* which resulted in the calling of a national meeting of foundrymen.

The invitation to this meeting was issued jointly and signed by 59 members of the Philadelphia Foundrymen's Association and 14 members of the Western Foundrymen's Association. It was presented to the foundrymen of the United States and Canada in the April, 1896, issue of *The Foundry* and sent out by Howard Evans inviting all foundrymen to a Philadelphia meeting May 12-14, 1896.

The result was the organization of A.F.A., with Francis Schumann, then President of the Philadelphia group, its first president; John A. Penton, Secretary, and Howard Evans, Treasurer.

Thus was the American Foundrymen's Association founded as a technical society that has represented the oldest of industries for a full half century and whose administration was guided in the early years—to the technical success and prominence it now enjoys—by many great scientists. Among them were Albert Sauveur, Percy Longmuir, Richard Moldenke, Thomas West, H. E. Field and H. Ries, to name only a few.

Since 1897 the American Foundrymen's Association has distributed to its membership 52 volumes of TRANSACTIONS—a chronological record of progress in the Arts and Science of Metal Founding. This year's technical sessions and exhibits will bring to our membership many new scientific developments and much new equipment made necessary by the requirements of war . . . in many cases never heretofore discussed or shown.

The continuing prosperity and progress of the foundry industry can be insured by selecting and encouraging ambitious youth to enter your employment, and to carry out the embryo thoughts that require time, patience and foresight to transform them into reality. It is our responsibility to stimulate the ambition and restore the hope of our young people. To accomplish this we must pay attention to the employees' "take home attitude."

The contents of this Pre-Convention issue of AMERICAN FOUNDRYMAN is illustrative of the effort that your past and present directors, your committees of the various A.F.A. divisions and branches of interest, and particularly your headquarters staff, have put forth in making this Golden Jubilee Convention and Exhibit a brilliant beacon of success from which our next 50 years of progress may be charted.

It is a real pleasure for your officers and staff to extend to every foundry in the Americas and those abroad an invitation to send a representative to this Fiftieth Anniversary Foundry Congress and Show so that he may personally convey to his company the many new developments in processes, materials and equipment that will be demonstrated in the largest exhibit ever held in connection with the casting and its allied industries. To our exhibitors, we extend our appreciation of their efforts in making this Show a success.

Fred J. Walls

FRED J. WALLS,
NATIONAL A.F.A. PRESIDENT.

AFA

50th ANNIVERSARY FOUNDRY CONGRESS AND SHOW

CLEVELAND

On May 6, the most important peace time gathering of foundrymen from the United States, Canada and abroad will assemble in Cleveland at the Cleveland Public Auditorium for the Golden Jubilee Foundry Congress. Never before has an annual A.F.A. convention program been studded with such an array of outstanding speakers, events and meetings of special interest to executives and shopmen of the foundry industry.

Registration and Headquarters

The Golden Jubilee Foundry Congress will get under way officially at 9:00 am, Monday, May 6, when registration begins in the main lobby of the Cleveland Public Auditorium, just off Lakeside Ave. It should be added that Official Headquarters for the Congress will be only the Public Auditorium, no hotel being designated as headquarters.

With a large staff of attractive young ladies on hand to handle registration, and a streamlined registration plan in effect this year for the first time, none of the usual opening day congestion is expected at the registration counters. As at all A.F.A. annual meetings, admission to meetings and exhibits will be by official badge, secured at the registration desk of the Auditorium.

In order to streamline the procedure this year, registration cards are being mailed to all A.F.A. members in advance of the Convention, for the convenience of registrants.

Aerial view of downtown Cleveland; arrow points out Cleveland Public Auditorium.

Any member planning to attend the Convention should fill out the registration card before coming to Cleveland and he may then present the card direct to those counters where his identification badge can be typed out. This means he will not have to be identified through the usual "member credential card" which is not being utilized this year.

Special arrangements for registration of members in the Northeastern Ohio, Central Ohio, Canton, Toledo and Northwestern Pennsylvania chapters are being made. Registration cards will be mailed these members and, when returned to the A.F.A. office in Chicago, the badges will be forwarded to those members complete. Those Ohio and Pennsylvania members who bring their badges with them can don them at the Auditorium and be immediately admitted without further registration formalities. It is expected that this will minimize registration delays.

The headquarters booth of the Association will be located in the Arena facing the main entrance from the Registration lobby. Here A.F.A. publications will be on sale as well as the Convention office of the American Foundryman. Exhibits will be located in the Arena, Main Exhibition Hall, North Hall, Arcade, and the Upper and Lower levels of Lakeside Hall. Desks for the various organizations servicing the Foundry Show will be located between the Main Exhibition Hall and North Hall. In the South Hall (see floor plans in this issue) A.F.A. has arranged for excellent restaurant facilities, offering both counter and table service, as a convenience to visitors and exhibitor representatives.

Exhibitor representatives who

come to Cleveland in advance of convention week, in order to install their company's product displays, may register in the A.F.A. Headquarters Office, which will be located immediately off the Registration lobby. Lunch counter service will be provided in South Hall on Saturday and Sunday, May 4 and 5, for the convenience of these early arrival exhibitor representatives.

Auditorium Houses Show

The Foundry Show will, of course, be housed in the Public Auditorium Exhibit Halls, and the majority of technical sessions also will be held there. Evening sessions, committee meetings and round table luncheons will be held in Hotel Statler and Hotel Cleveland. Those who plan to attend luncheon and dinner meetings staged by the Association are being asked to fill out and return to National Headquarters a special form now being mailed all members, and to indicate the events they will attend so that arrangements can be made for dinner and luncheon service. These forms should be returned direct to the National Office, 222 West Adams St., Chicago 6.

Elsewhere in this Golden Jubilee issue of AMERICAN FOUNDRYMAN will be found the official program of technical sessions, as well as an official list of exhibitors compiled as of press time.

The entire morning of Monday, May 6, has been left entirely open for inspecting exhibits, no technical sessions being planned before noon. This means that the usual "opening meeting," a feature of several past conventions, has been eliminated so as to conserve the time of those who may be planning to reach Cleveland the morning of opening day, visit the exhibits in the forenoon, attend the technical sessions during the afternoon and evening and depart for home the same night. This same consideration has governed formulation of the week's program, in recognition of the possibility that hotel accommodations at this time may not be sufficient to care for the expected capacity crowd.

Tuesday afternoon and evening, May 7, from 1 pm to 10 pm has been designated Northeastern Ohio Day, during which time the exhibits will remain open for the benefit of foundrymen in Cleveland and surrounding areas. In fact, it is expected that many plant men will drive in from many outlying towns to spend the afternoon and evening and return home late Tuesday night in time for work the next day. Announcement has been made of this opportunity to plants in the Canton, Central Ohio, Northwestern Pennsylvania and Toledo chapter territories.

Admission to Northeastern Ohio Day will be by special card only, and obtainable by plant executives through the Northeastern Ohio Day Committee of the Northeastern Ohio chapter. The chairman of the N.E.O. Day Committee is Edw. Follman, Griffin Wheel Co., Cleveland. No charge is made for these admission cards which are good only for the hours of 1 pm to 10 pm May 7.

In this way a maximum number of interested foundrymen in the area surrounding Cleveland will have a chance to see the advancements and improvements made in equipment and materials used for the production of castings.

Annual Business Meeting

The one mid-week event requiring special arrangements will be the Annual Business Meeting of the Association scheduled for Thursday, May 9, at 9:30 am. At this meeting, National President F. J. Walls, International Nickel Co., Detroit, will present the Annual President's Address, and, during the period of the meeting, power will be shut off for operating exhibits and lights in the Exhibit Halls will be dimmed. All visitors to the 50th Anniversary Convention are urged to attend this important meeting, the one event of the year in which the Association's National Officers and Directors have an opportunity to meet the combined membership face to face. With a present membership of over 8,000 a capacity crowd is expected for the Annual Business Meeting.

At this meeting, the report on election of new Officers and Directors of A.F.A. will be presented by the National Secretary, giving the membership an opportunity to greet their newly selected leaders.

Another outstanding event of the Annual Business Meeting will be the presentation of the fourth A.F.A. Foundation Lecture by Dr. Guilliam H. Clamer, president, Ajax Metal Co., Philadelphia, and an A.F.A. gold medalist. Dr. Clamer has chosen for his subject "Test Bars for 85 Copper—5 Tin—5 Lead—5 Zinc Alloy—Design and Some Factors Affecting Their Properties." A nationally-known and outstanding metallurgist in Brass and Bronze, Dr. Clamer's Lecture is expected to continue the splendid tradition of the Foundation Lectures, which have consistently resulted in valuable contributions to the literature of the foundry industry.

Annual Dinner

As previously announced, the Annual Dinner of the Association will be served Friday night, May 10, at 7 o'clock in the Grand Ballroom, Hotel Statler. This gala event, representing the climax to the Golden Jubilee Foundry Congress, will feature a nationally known speaker.

National President Walls will preside at the Annual Dinner, at which presentations will be made of A.F.A. gold medal awards and Honorary Life Memberships, bestowed by action of the Board of Awards for outstanding service and contributions to foundry practice. The 1946 recipients of these Association honors are announced elsewhere in this pre-Convention issue.

The Official Housing Bureau of A.F.A., located at 511 Terminal Tower, Cleveland 13, Ohio, will function right through the entire convention week. Prior to May 6, the Housing Bureau will assign hotel rooms in accordance with requests up to the maximum limit of the liberal housing guarantee given A.F.A. by the Cleveland hotels. During the convention, Housing Bureau headquarters will be located at the Auditorium and any visitors whose advance applications for rooms could not be taken care of are requested to contact the Bureau at the Auditorium immediately on arrival. Arrangements have been made for housing the overflow in private homes, and every courtesy will be extended in an effort to take care of all who reach Cleveland without confirmed hotel reservations. Rooms in private homes, however, will not be assigned in advance of convention arrivals.

A complete list of Golden Jubilee Exhibitors will be found on pages 93-96 of the current issue, listing the more than 250 companies who

will display their products and product applications at the 1946 Foundry Show. Unlike the 1944 War Production Foundry Show in Buffalo, this will be an "all out" exhibit year with practically unlimited power available for operating displays. Indications are that exhibitors are taking fine advantage of this opportunity to aid the reconversion of the foundry industry with many new items of equipment, materials and supplies.

Official Hours

Official opening hour for the Exhibits will be 9 am Monday, May 6. The Show will remain open until 10 pm on May 7, and until 5:30 pm all other days of the week except Friday, when the official closing hour for the 1946 Exhibits will be 4:30 pm.

Gray Iron Division—The Gray Iron Division is sponsoring one of its most outstanding Convention programs this year, including a 2-session Symposium on Engineering Properties of Gray Iron, scheduled for May 8, with design engineers urged to attend on special invitation. The Symposium will include 4 papers on Engineering Properties plus a special paper prepared specifically for use by men who design metal parts.

All the Gray Iron sessions are being confined to May 8, 9 and 10, for time-saving purposes, except for two sessions of the 4-session Annual Shop Course. Three Technical sessions are scheduled, including one on Welding. In addition, one phase of the Annual Sand Shop Course will deal with Gray Iron Sand Control, and one phase of the Annual Lecture Course will be devoted to Gray Iron Foundry Control.

The Gray Iron Shop Course will be especially interesting this year commencing with a discussion of the Metallurgy of Cupola Mixes. This will be followed by two sessions covering the splendid work of the A.F.A. Casting Defects Committee, shortly to be published in booklet form and one of the most outstanding and practical pieces of Gray Iron literature to be issued in many years. Session 4 of the Shop Course will deal with Metallurgy of Carbon Control in the Cupola.

An exchange paper from the French Technical Society will be presented at one of the several Gray Iron Technical sessions, marking a resumption of exchange relations with French foundrymen after a wartime break of nearly 7 years.

Steel Division — In accordance with plans to conserve the time of foundrymen the steel sessions will be confined to May 8, 9, and 10, beginning with a technical session the afternoon of May 8. Two additional technical sessions will offer a total of 13 valuable papers on steel practice, including the I.B.F. Exchange Paper and 2 manuscripts from Russia.

A round table luncheon, always a popular event, again is provided for. Steel Foundry Control will be covered as one phase of the Annual Lecture Course. The Annual Sand Shop Course also will have a session dealing with Steel Sand Control.

Aluminum and Magnesium Division—The sessions on Aluminum and Magnesium will be confined to May 6 and 7, including 3 technical meetings and a round table luncheon. Some 5 papers will be presented by various authors and these events deal with Die Castings, Permanent Mold Castings, Microporosity, Mold Materials, and Centrifugal Casting of Magnesium.

Magnesium Control

One session of the Annual Lecture Course will deal with Aluminum and Magnesium Foundry Control. Magnesium Molding Sands will be discussed at one of the Annual Sand Shop Course sessions.

Brass and Bronze Division—The Brass and Bronze Division meetings extend over 3 days, May 8-10, and will include 3 technical sessions and a round table luncheon. At these meetings a total of 8 papers have been scheduled, including the 6th Annual Report of A.F.A. Work on Properties of Sand at Elevated Temperatures. The authors of Nonferrous papers this year are concentrating on Sand Practice Section and Size, Alloys Combustion, and Metal Flow.

Included in the Annual Sand Shop Course will be one session on Brass and Bronze Sand Control and a phase of the Annual Lecture Course will cover Brass and Bronze Foundry Control. All in all, the non-ferrous foundryman will find a great deal of value in this year's Brass and Bronze program.

Malleable Division—As with Brass and Bronze, the Malleable program will extend over 3 days, May 6-8, and will include 3 technical sessions, a round table luncheon meeting, a session of the Annual Lecture Course dealing with Malleable Foundry Control, and one phase of the Annual Sand Shop Course covering Malleable Foundry Sands. Some half dozen papers on various phases of core practice and chemical composition will feature the Malleable program.

Patternmaking Division—Only one session has been scheduled by the Patternmaking Division and this will include 2 papers. One of these will cover the Use of Wood Models in Planning and Design, the other one, Patterns for Production Foundry.

Annual Lecture Course—The Annual Lecture Course will be staged again in 1946, and this year will include 5 sessions, one covering each of the 5 A.F.A. metal casting divisions. The general subject to be dealt with is Foundry Control, and sessions of the course will be devoted to Aluminum and Magnesium, Malleable Iron, Brass and Bronze, Steel and Gray Iron Castings.

Shop Operation Course — Two separate Shop Operation Courses will be offered at the 1946 Convention, one on gray iron, and one on sand practice in various types of foundries. The Gray Iron Shop Operation Course will consist of 4 sessions covering Cupola Mixes and Casting Defects. (Two meetings on Carbon Control.) The Sand Shop Course, comprising 5 meetings of interest, will deal with Magnesium, Malleable, Brass and Bronze, Gray Iron and Steel.

General Interest Sessions — The Foundry Cost Committee has worked up some special data for this year's program dealing with a cost system for small shops, and this system will be discussed thoroughly at a technical session.

Inspection Session

The Castings Inspection Committee, organized in 1944, has scheduled 2 technical meetings on May 7, one in the morning and another in the afternoon. At these meetings 3 formal papers will be offered by a panel discussion of "Suppliers' and Buyers' Viewpoint of Inspection in the Foundry." At this latter event

City of Cleveland

THOMAS A. BURKE
MAYOR

PROCLAMATION

Proclaiming the week of May 6, 1946
as FOUNDRY WEEK in Cleveland

WHEREAS, the more than 5,000 aluminum, brass and bronze, gray iron, magnesium, malleable iron and steel foundries of the United States constitute a great and basic industry, highly important to the industrial life, progress and economic well-being of the Nation and the City of Cleveland; and

WHEREAS, the foundries of Cleveland have contributed immeasurably to the City's growth as the heart and center of an outstanding manufacturing region and have become in number, capacities and skills a large and nationally important segment of the metal-working industries; and

WHEREAS, the foundry industry, which annually produces millions of tons of castings extensively used as components of a wide range of producers' and consumers' durable goods, played a vital, basic part in Cleveland's and the Nation's war effort, and then, with exemplary swiftness, converted to peacetime production and peacetime jobs with a minimum of dislocation; and

WHEREAS, the American Foundrymen's Association, the technical society of the castings industry, is holding its 50th anniversary convention and a massive foundry equipment and materials exposition in Cleveland's Public Auditorium May 6th to 10th, inclusive:

NOW, THEREFORE, I, Thomas A. Burke, as Mayor of the City of Cleveland, do hereby proclaim the week of May 6th of Cleveland's Sesquicentennial Year as FOUNDRY WEEK in Cleveland, and do call the attention of the people of Cleveland to the contribution which is made to the industrial greatness, the wealth and progress of our City and our Nation by the foundry industry; and I extend, in the name of the people of Cleveland, a hearty welcome to the thousands of foundrymen from all over the world who are coming to Cleveland during FOUNDRY WEEK and the year of the City's Sesquicentennial celebration.

Dated this 12th day of April, A.D. 1946.

Thomas A Burke
Mayor.

5 men of the foundry and buyers of castings will collaborate for a subject discussion.

The Plant and Plant Equipment Committee has joined hands this year with the Safety and Hygiene Committee to stage 2 joint technical meetings, both on May 6. The afternoon session will feature 2 papers and the evening session will comprise a panel discussion on "Dust Control Equipment, Its Application, Operation and Maintenance." Panel leaders at this discussion have been selected on the basis of promulgating the work of A.F.A. in these important fields.

General Interest Sessions

Training and Education — The several committees dealing with Apprentice Training and Engineering School phases of foundry education have organized an excellent program dealing with realities and with all sessions confined to the two days, May 8 and 9. Two Apprentice Training sessions are scheduled the latter date, plus a dinner meeting at which tribute will be paid to those pioneers who have labored for the cause of foundry apprenticeship over the past half century.

On May 8, a session on Foreman Training is one of the educational features plus a panel discussion on phases of engineering school training. At the latter meeting, several prominent engineering school instructors will present their views on what the foundries must do to obtain college graduates, while several foundry executives will express their thoughts on the type of college trained man the foundries need. On the same date, the annual Foundry Instructors Dinner will be staged, a get-together for men who have at heart the subject of engineering training for foundry work.

Another informal session scheduled for May 7 will be a luncheon for Alumni and engineering schools. Tables will be placarded for schools such as Purdue, M.I.T., Michigan and the like where alumni of each school can get together to talk over old times and present problems.

The Job Valuation and Time Study Committee has arranged for two meetings at this Convention, both on May 9. An afternoon session will be devoted to discussion of the importance of Time Study Work to Management. In the evening a panel discussion will be conducted on the Committee's work and what can be accomplished in the future in the way of Time Study and Job Evaluation activities on the part of foundries.

Panel Discussion

Refractories—As sponsored by the Refractories Committee, a feature of the Refractories session will be an "Information Please" question and answer panel on foundry refractories. Four panel leaders will conduct the discussion of this unique event, which should produce a great deal of practical information. In addition, a technical session on Refractories will be staged for which 4 papers have been scheduled covering various applications in the foundry field.

A luncheon for Canadian members of A.F.A. was staged for the first time at the Buffalo Convention in 1944, but the attendance was far greater than the facilities provided. Such a luncheon has been scheduled again this year and all Canadian members will be requested to indicate their intention of attending. Advance knowledge of attendance is necessary so that proper facilities can be provided and it is expected that the event this year will prove to be more popular than ever before, due largely to the increased interest and enthusiasm of the two A.F.A. Canadian chapters, Ontario and Eastern Canada-Newfoundland chapters.

First Convention of A.F.A. Called In 1896

Two organizations of foundrymen were largely responsible for the call that brought men in the industry together in Philadelphia for the first Convention of the new American Foundrymen's Association, May 12-14, 1896. Held under the auspices of the Philadelphia Foundrymen's Association, which became the Philadelphia Chapter of A.F.A. in 1935, the Western Foundrymen's Association of Chicago joined in issuing the official invitation.

This invitation contains the names of many outstanding foundrymen who became known throughout the industry and remained active in A.F.A. affairs for many years thereafter. Signatories of the document that resulted in the first Annual Meeting of your Association, as listed in the April 1896 issue of *The Journal of A.F.A.*, were:

Francis Schuman, Tacony Iron & Metal Co., Tacony, Pa.

P. D. Wanner, Reading Foundry Co., Ltd., Reading, Pa.

Josiah Thompson, J. Thompson & Co., Philadelphia.

Howard Evans, J. W. Paxson & Co., Philadelphia.

Walter Wood, R. D. Wood & Co., Philadelphia.

Thos. Glover, Glover Bros., Frankford, Pa.

E. E. Brown, E. E. Brown & Co., Philadelphia.

Stanley G. Flagg, Jr., Stanley G. Flagg & Co., Philadelphia.

Wm. F. Sauter, G. Rebmann & Co., Philadelphia.

Jno. M. Sweeney, Chicago Cons. Iron & Steel Co., Harvey, Ill.

A. W. McArthur, Rockford Foundry Co., Rockford, Ill.

O. T. Stantial, Illinois Malleable Iron Co., Chicago.

S. T. Johnston, Whiting Foundry Equipment Co., Chicago.

Geo. M. Sargeant, The Sargeant Co., Chicago.

W. N. Moore, Joliet Stove Works, Joliet, Ill.

James Frake, Chicago.

A. Sorge, Jr., M. E., Chicago.

Thos. D. West, The Thos. D. West Foundry Co., Sharpsville, Pa.

E. E. Hanna, Gates Iron Works, Chicago.

Wm. Ferguson, Gates Iron Works, Chicago.

J. H. Dalton, Walburn, Swenson Co., Chicago.

B. M. Gardner, Iron Trade Review, Chicago.

John Pettigrew, Illinois Steel Co., Joliet, Ill.

Included in the list are four past Presidents of A.F.A.: Francis Schuman, first Association President; Stanley G. Flagg, Jr.; S. T. Johnston and Thos. D. West.

It is a matter of record that this first meeting proved to be a huge success and in reporting the affair and giving credit for arrangements to Howard Evans, then Secretary of the Philadelphia group, one reporter stated "This gentleman is likely to live to see his own monument erected (a distinction accorded to but few men in this world) in the shape of a Foundrymen's Association that is likely to make its influence felt in a way that may surprise some of even its most sanguine friends."

With the present membership of 8,000 including distinguished foundrymen and metallurgists from

countries throughout the world, the reporter's enthusiasm seems not to have been too exaggerated. It is recorded that some 350 interested individuals attended the first meeting in 1896 . . . a figure that may be compared with the nearly 7,000 who were presented at the 48th Annual Meeting of A.F.A. in 1944, and the expected record-breaking attendance already gathering as the Association observes its 50th Anniversary.

EXCHANGE PAPERS

Represent Foundrymen of Four Lands

THAT THE TECHNICAL PROGRAM of A.F.A.'s 50th Anniversary Convention is definitely post-war in character—and pre-war in diversity, scope and range of interest—is indicated by the number and variety of exchange papers it features.

First Australian Paper

Scheduled for a Brass and Bronze Division session Friday, May 10, is the first exchange paper to be submitted to an A.F.A. meeting by the Institute of Australian Foundrymen . . . a thorough-going discussion of "Manganese Bronze" by H. E. Arblaster, chief metallurgist of Stokes & Sons Pty., Ltd., and Stokes Foundries Pty., Ltd., Brunswick, Melbourne. The paper sets out the composition of some alloys of nominated mechanical properties and examines at some length the relationships of amounts of alloying elements to structure and properties.

The presentation of the French foundry association, Association Technique de Fonderie, and its first since 1938, is a paper entitled "The Technical Organization of the French Foundry Industry." Written by Auguste LeThomas, Director General of Centre Technique, Paris, and president of the technical committee of the French foundry industry, the paper will describe the technical "reconversion" program of the industry of France under a state-controlled organization managed by foundrymen. Mr. LeThomas has long contributed to the technical advancements and technical literature of the French foundry industry, and received one of the first gold medals awarded by the Association Technique de Fonderie de France.

Extending a long exchange series, the Institute of British Foundrymen will present a paper by Basil Gray of the English Steel Corp., Ltd., Sheffield. Entitled "The Production of 'Grand Slam' Bomb Castings," it outlines an old but little known foundry technique which, in a revised version, was employed to produce the "block-busters" that perforated the 20-foot-thick concrete roof of the U-boat pens at Hamburg and shook to pieces the masonry of the viaduct of the Bielefeld railway, the last uncut main line to Belgium and the Ardennes during the fighting there in the spring of 1945.

The IBF paper will be presented by Mr. Gray at a steel division of the Jubilee Congress Friday, May 10. That session will also feature unofficial papers by two Russian technicians, Victor M. Shestopal, professor in the Stalin Machine Tool Institute and N. B. Gelperin, chief engineer, Moscow division, State Institute "Giprotjagmashe."

An official Czech paper by Dr. Volejnik is also anticipated.

Information Offered On Design With Gray Iron

HIGHLIGHTING the gray iron program at the 50th Anniversary Foundry Congress in Cleveland will be a Symposium on Engineering Properties of Gray Cast Iron, arranged particularly to provide information useful to design engineers. The symposium will be offered in two sessions, a morning and an afternoon session on Wednesday, May 8, and special effort is being made to invite attendance by mechanical and tool engineers who are responsible for the design, specification and purchase of metal parts.

At the morning session W. E. Mahin, Armour Research Foundation of Illinois Institute of Technology, Chicago, will present a compilation of the engineering properties of gray iron in the language of the design engineers. This important paper is being specially prepared for castings users. Nationally known metallurgists and engineers will participate in an information panel at this meeting.

The afternoon session will be devoted to discussion of specific properties, such as wear resistance, ductility and elasticity, effect of section size on tensile properties, and the relation between tensile tests and rupture stresses. Papers will be presented by C. H. Lorig and T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio; F. G. Sefing, International Nickel Co., New York; H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y.; and R. A. Flinn, Jr., and H. J. Chapin, American Brake Shoe Co., Mahwah, N. J.

All A.F.A. Chapters have been notified of the 1946 Symposium, with the request that design engineers in each chapter area be invited to attend. The sessions have been planned so that an engineer can arrive in Cleveland the morning of May 8, attend both sessions of the symposium, attend the Foundry Show and return home the same night, if desired.

Gray Iron Foundry members of A.F.A. are urged to personally write design engineers to be present, so as to bring out the full possibilities of this unique meeting.

The symposium originally scheduled for the canceled 1945 convention, is expected to prove one of the most important programs ever presented at an A.F.A. meeting. Under the chairmanship of T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa., it sets a pattern for the presenting of practical information which might well be considered by divisions of the Association.

Visit National Office

Recent visitors at the National Office included two A.F.A. members from England here on inspection of American foundries. **G. L. Hancock**, who is Branch Manager, David Brown & Sons (Huddersfield), Ltd., brass and steel founders of Sheffield, England, is traveling with **R. S. Pratt**, Assistant Works Superintendent, P. R. Jackson & Co., Ltd., steel founders of Manchester. Both expect to attend the big Convention and Exhibit in May before returning home.

AFA
Golden Jubilee Program

IN TUNE WITH FOUNDRY RECONVERSION NEEDS

MONDAY, MAY 6

9:00 AM—Registration Begins.

9:00 AM—Exhibits Open.

12:00 PM—Aluminum & Magnesium Round Table Luncheon.

(Sponsored by Aluminum and Magnesium Division)

Presiding—R. E. Ward, Eclipse Pioneer Div., Bendix Aviation Corp., Bendix, N. J.

Co-Chairman—A. T. Ruppe, Bendix Products Corp., South Bend, Ind.

"Report of Committee on Recommended Practices for Aluminum and Magnesium Die Castings"—By J. C. Fox, Doehler-Jarvis Corp., New York.

"Report of Committee on Recommended Practices for Aluminum and Magnesium Permanent Mold Castings"—By A. Sugar, American Metal Co. Ltd., New York.

2:00 PM—Joint Meeting, Plant Equipment and Safety & Hygiene.

(Sponsored by Safety and Hygiene Committee and Plant & Plant Equipment Committee)

Presiding—James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.

Co-Chairman—C. P. Guion, W. W. Sly Mfg. Co., Chicago.

"Accident Prevention as a Function of Management"—By R. R. Meigs, Liberty Mutual Insurance Co., Boston.

"Mechanical Shakeouts"—By J. L. Yates, Worthington Pump & Machinery Corp., Buffalo, N. Y.

4:00 PM (A)—Lecture Course (Session 1).

(Sponsored by Annual Lecture Committee)

Presiding—D. Basch, Almin Co., Schenectady, N. Y.

Co-Chairman—H. Brown, Aluminum Industries Inc., Cincinnati.

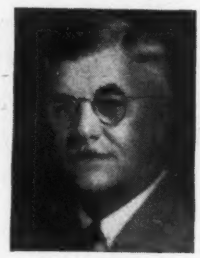
Subject—*"Aluminum and Magnesium Foundry Control."*

Discussion Leader—Oscar Blohm, Hills-McCanna Co., Chicago.

J. L. Yates

R. E. Ward

A. T. Ruppe



James Thomson

C. P. Guion

Hiram Brown

F. S. Brewster

P. T. Bancroft

R. R. Meigs

4:00 PM (B)—Gray Iron Shop Course (Session 1).

(Sponsored by Gray Iron Division, Shop Operation Course Committee)

Presiding—George A. Timmons, Climax Molybdenum Co., Detroit.

Co-Chairman—P. T. Bancroft, Republic Coal & Coke Co., Moline, Ill.

Subject—*"The Metallurgy of Cupola Mixes."*

Discussion Leader—K. H. Priestley, Eaton Mfg. Co., Vassar, Mich.

H. Bornstein

C. A. Brashares

C. E. Sims

E. E. Woodliff

V. A. Crosby

M. V. Chamberlin

S. Appelby

L. Brown

T. E. Barlow

D. F. Sawtelle

M. J. Gregory

W. J. Hebard

F. G. Sefing

H. F. Bishop

F. E. Wartgow

W. B. George

A. S. Klopf

F. W. Boulger

Program

MONDAY, MAY 6 (Cont.)

8:00 PM (A)—Sand Shop Course (Session 1).

(Sponsored by Sand Shop Operation Course Committee)

Presiding—F. S. Brewster, Dow Chemical Co., Bay City, Mich.

Subject—*"Magnesium Molding Sands."*

Discussion Leader—Oscar Blohm, Hills-McCanna Co., Chicago.

8:00 PM (B)—Joint Meeting, Plant Equipment and Safety & Hygiene.

(Sponsored by Safety and Hygiene Committee and Plant & Plant Equipment Committee)

Presiding—James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.

Co-Chairman—W. O. Vedder, Pangborn Corp., Hagerstown, Md.

"Exhaust Hoods and Piping Systems"—By E. A. Carsey, Kirk & Blum Mfg. Co., Cincinnati.

"Dust Collection and Disposal"

"Centrifugal Collectors"—By H. C. Dohrmann, Buell Engineering Co., New York.

"Cloth Collectors"—By G. A. Boesger, W. W. Sly Mfg. Co., Cleveland.

"Web Collectors"—By A. S. Lundy, Claude B. Schneible Co., Detroit.

"Fans and Exhausters"—By Phillip Cohen, B. F. Sturtevant Co., Cleveland.

"Maintenance"—By K. M. Smith, Caterpillar Tractor Co., Peoria, Ill.

8:00 PM (C)—Aluminum and Magnesium.

(Sponsored by Aluminum and Magnesium Division)

Presiding—Leslie Brown, Magnesium Fabricators Div., Bohn Aluminum & Brass Corp., Adrian, Mich.

Co-Chairman—G. G. Glider, Ebaloy Foundries Inc., Rockford, Ill.

"Interrelation of Various Major Factors Determining the Amount of Microporosity in Magnesium Alloy Castings"—By L. W. Eastwood and J. A. Davis, Battelle Memorial Institute, Columbus, Ohio.

"The Effect of Mold Materials and Practices on the Quality of Magnesium Alloy Castings"—By M. V. Chamberlin and J. G. Mezoff, Dow Chemical Co., Midland, Mich.

"Centrifugal Casting of a Magnesium Part"—By F. P. Strieter and R. J. Maenner, Dow Chemical Co., Midland, Mich.

Program

TUESDAY, MAY 7

10:00 AM (A)—Malleable Foundry Practice.
(Sponsored by Malleable Division)

Presiding—A. M. Fulton, Northern Malleable Iron Co., St. Paul, Minn.

Co-Chairman—C. F. Joseph, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.

"Chemical Composition of Malleable Iron"—By H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland.

"Cores for Automotive Malleable Iron Castings"—By W. G. Ferrell, Auto Specialties Mfg. Co., St. Joseph, Mich.

10:00 AM (B)—Aluminum and Magnesium Session.
(Sponsored by Aluminum and Magnesium Division)

Presiding—Walter Bonsack, National Smelting Co., Cleveland.

Co-Chairman—T. D. Stay, Reynolds Metals Co., Cleveland.

"Heat Treatment of Aluminum Alloy Castings"—By Walter E. Sicha and H. J. Rowe, Aluminum Co. of America, Pittsburgh, Pa.

"The Effect of Certain Elements on Some Properties of an Aluminum Sand Casting Alloy"—By R. A. Quadt, American Smelting & Refining Co., Barber, N. J.

"Characteristics of Aluminum Casting Alloy 3 Per Cent Silicon—5 Per Cent Copper"—By O. Tichy, National Smelting Co., Cleveland.

10:00 AM (C)—Inspection of Castings.
(Sponsored by Inspection of Castings Committee)

Presiding—Harold W. Warner, Allis-Chalmers Mfg. Co., Milwaukee.

Co-Chairman—E. G. Leverenz, American Steel Foundries, East Chicago, Ind.

"Duties and Functions of the Inspection Dept., As Seen by Management"—By M. D. Johnson, Purolator Products Inc., Newark, N. J.

"Inspection—The Backbone of Quality Control"—By W. H. Gunselman, Samuel Greenfield Co., Inc., Buffalo, N. Y.

"Non-Destructive Inspection of Castings"—By C. L. Frear and R. E. Lyons, Bureau of Ships, U. S. Navy Department, Washington, D. C.

12:00 PM (A)—Luncheon — Engineering School Alumni Groups.

Presiding—F. G. Sefing, International Nickel Co., New York.


C. F. Joseph


H. J. Rowe


A. M. Fulton


J. G. Kura


D. I. Dobson

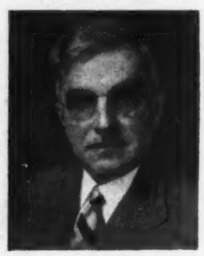

C. E. Bales


W. O. Vedder


J. H. Lansing


G. J. Barker


J. D. Amoroso


H. A. Schwartz


W. H. Gunselman


A. W. Stolzenburg


E. F. Platt


G. A. Timmons


W. A. Hambley


W. D. McMillan


W. B. McFerrin

J. J. Clark

D. Frank O'Connor

R. H. Stone

J. A. Bowers

R. H. Hardy

H. L. Smith

H. F. Taylor

R. G. McElwee

H. W. Dietert

R. E. Morey

W. E. Mahin

H. H. Blosjo

A. I. Krynitsky

A. H. Hesse

Program

TUESDAY, MAY 7 (Cont.)

12:00 PM (B)—Canadian Members' Luncheon.

Presiding—Jos. Sully, Sully Brass Foundry, Toronto, Ont.

1:00-10:00 PM—Northeastern Ohio Day.

Chairman—Edw. Follman, Griffin Wheel Co., Cleveland.

(Admission to Northeastern Ohio day will be by special card only, which may be obtained at no charge from the Northeastern Ohio Day Committee of the Northeastern Ohio chapter.)

2:00 PM (A)—Inspection of Castings.
(Sponsored by Inspection of Castings Committee)

Presiding—E. F. Platt, Sperry Gyroscope Co., Brooklyn, N. Y.

Co-Chairman—W. H. Gunselman, Samuel Greenfield Co. Inc., Buffalo, N. Y.

Panel Discussion: *"Suppliers' and Buyers' Viewpoint of Inspection in the Foundry."*

Discussion Leaders:

C. H. Thomas, Chicago & Northwestern R. R., Chicago.

Walter Klayer, Aluminum Industries Inc., Cincinnati.

John Amoroso, Sterling Engine Co., Buffalo, N. Y.

G. Dewald, Ampco Metals, Inc., Milwaukee.

E. Walcher, Jr., American Steel Foundries, Chicago.

2:00 PM (B)—Refractories.
(Sponsored by Refractories Committee)

Presiding—C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio.

Co-Chairman—C. S. Reed, Chicago Retort & Fire Brick Co., Chicago.

"Suggested Cupola Refractory Standardization"—By R. P. Stevens, Chicago Retort & Fire Brick Co., Chicago.

"Foundry Refractories—Their Properties and Application"—By C. A. Brashares, Harbison-Walker Refractories Co., Pittsburgh, Pa.

"Refractories in Non-Ferrous Practice"—By H. R. Kohl, General Electric Co., Erie, Pa.

"The Use of Rammed Refractories in Electric Steel Foundries"—By R. H. Zoller, Zoller Castings Co., Bettsville, Ohio.

Program

S. A. Herres

C. R. Jelm

E. R. Young

W. M. Ball, Jr.

C. H. Lorig

TUESDAY, MAY 7 (Cont.)

2:00 PM (C)—Malleable Foundry Practice.
(Sponsored by Malleable Division)

Presiding—R. J. Anderson, Belle City Malleable Iron Co., Racine, Wis.

Co-Chairman—D. I. Dobson, General Malleable Corp., Waukesha, Wis.

"Malleable Foundry Core Making Practice for Pipe Fittings and Small Castings"—By D. F. Sawtelle, Malleable Iron Fittings Co., Branford, Conn.

"Core Sand Practice and Control in a Mechanized Malleable Iron Foundry"—By Joseph J. Clark, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.

4:00 PM (A)—Aluminum and Magnesium.
(Sponsored by Aluminum and Magnesium Division)

Presiding—W. E. Martin, National Smelting Co., Cleveland.

Co-Chairman—A. W. Stolzenburg, Aluminum Co. of America, Detroit.

Committee Report: *"Unsoundness in Cast Light Alloys"*—By L. W. Eastwood, Battelle Memorial Institute, Columbus, Ohio. (A.F.A. Committee on Shrinkage and Porosity.)

"Report of Committee on Dimensional Stability of Aluminum Castings"—By Hiram Brown, Aluminum Industries, Inc., Cincinnati.

"The Relation of Design and Metallurgical Factors to Serviceability of Magnesium Castings"—By G. H. Found, Dow Chemical Co., Bay City, Mich.

4:00 PM (B)—Gray Iron Shop Course (Session 2).
(Sponsored by Gray Iron Division, Gray Iron Shop Course Committee)

Presiding—W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee.

Co-Chairman—George W. Anselman, Goebig Mineral Supply Co., Chicago.

"Casting Defects Attributable to Metal"—A.F.A. Committee on Analysis of Castings Defects.

4:00 PM (C)—Lecture Course (Session 2).
(Sponsored by Annual Lecture Committee)

Presiding—W. B. McFerrin, Electro Metallurgical Co., Detroit.

Co-Chairman—W. D. McMillan, International Harvester Co., McCormick Works, Chicago.

"Malleable Foundry Control"—By C. F. Joseph, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.

7:00 PM—Chapter Officers and Directors Dinner.

Presiding—S. V. Wood, Minneapolis Electric Steel Castings Co., Minneapolis, Minn., and Vice-President, American Foundrymen's Association.

8:00 PM (A)—Refractories.
(Sponsored by Refractories Committee)

Presiding—C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio.

Co-Chairman—C. S. Reed, Chicago Retort & Fire Brick Co., Chicago.

"The Lining and Patching of Cupolas"—By E. J. Lally, Jr., Forest City Foundries Co., Cleveland.

"Information Please" on Foundry Refractories—Question and Answer Panel.

Moderator—C. S. Reed, Chicago Retort & Fire Brick Co., Chicago.

Panel Leaders:

Richard H. Stone, Vesuvius Crucible Co., Swissvale, Pa.

J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.

E. J. Carmody, Chas. C. Kawin Co., Chicago.

A. S. Klopf, Lester B. Knight & Associates, Inc., Chicago.

8:00 PM (B)—Sand Shop Course (Session 2).
(Sponsored by Sand Shop Operation Course Committee)

Presiding—D. F. Sawtelle, Malleable Iron Fittings Co., Branford, Conn.

Subject—*"Malleable Molding Sand Control."*

Discussion Leaders:

E. C. Zirzow, National Malleable & Steel Castings Co., Cleveland.

L. Richard Spann, Eastern Malleable Iron Co., Naugatuck, Conn.

Program


H. M. St. John


F. C. Cech


C. J. Freund


C. O. Thieme


William C. Wick


A. K. Higgins


S. G. Garry


J. A. Duma


S. W. Brinson


T. D. West


R. A. Clark


F. L. Riddell

WEDNESDAY, MAY 8

10:00 AM (A)—Malleable Foundry Practice.
(Sponsored by Malleable Division)

Presiding—W. D. McMillan, International Harvester Co., McCormick Works, Chicago.

Co-Chairman—D. F. Sawtelle, Malleable Iron Fittings Co., Branford, Conn.

"Core Practice in an Agricultural Malleable Foundry"—By Eric Welander, Union Malleable Iron Works, East Moline, Ill.

"Malleable Core Making Practice"—By E. C. Zirzow, National Malleable & Steel Castings Co., Cleveland.

10:00 AM (B)—Brass and Bronze.
(Sponsored by Brass and Bronze Division)

Presiding—D. Frank O'Connor, American Saw Mill Machine Co., Hackettstown, N. J.

Co-Chairman—Herman Smith, Federated Metals Div., American Smelting & Refining Co., Pittsburgh, Pa.

"Observations on Gas Elimination in Non-Ferrous Alloy Castings"—By George Dalbey, U. S. Navy Yard, Mare Island, Calif.

"Correct Combustion for Crucible Furnace Melting"—By A. C. Schmid, Jos. Dixon Crucible Co., Jersey City, N. J.

"Conditions of Flow in Bronze Castings"—By Lt. J. T. Robertson and R. G. Hardy, Naval Research Laboratory, Washington, D. C.

10:00 AM (C)—Sand Research.
(Sponsored by Foundry Sand Research Project, Technical Development Program)

Presiding—H. F. Taylor, Massachusetts Institute of Technology, Cambridge, Mass.

Co-Chairman—J. A. Rassenfoss, American Steel Foundries, Indiana Harbor, Ind.

"Sixth Annual Report of Committee on Physical Properties of Foundry Sands at Elevated Temperatures"—By D. C. Williams, A.F.A. Research Fellow, Cornell University, Ithaca, N. Y.

"Heat Absorption of Sand"—By H. W. Dietert and Robert L. Doelman, Harry W. Dietert Co., Detroit.

10:00 AM (D)—Symposium on Engineering Properties of Gray Iron.
(Sponsored by Engineering Properties Committee, Gray Iron Division)

Presiding—R. G. McElwee, Vanadium Corp. of America, Detroit.

Co-Chairman—W. E. Mahin, Armour Research Foundation, Illinois Institute of Tech., Chicago.

"The Engineering Properties of Gray Iron"—By W. E. Mahin, Armour Research Foundation, Chicago.

12:00 PM (A)—Brass and Bronze Round Table Luncheon.
(Sponsored by Brass and Bronze Division)

Presiding—B. A. Miller, Baldwin Locomotive Works, Cramp Brass & Iron Foundries Div., Philadelphia.

Co-Chairman—C. Louis Lane, Florence Pipe Foundry & Machine Co., Florence, N. J.

"Synthetic Versus Natural Sands"—By M. T. Ganzauge, General Railway Signal Co., Rochester, N. Y.

"Molding Sands for Brass and Bronze"—By L. B. Osborne, Hougland & Hardy, Inc., Evansville, Ind.

"The Effect of Section Size and Chills on Properties of Sand-Cast Bronzes"—By W. B. George and A. H. Hesse, R. Lavin & Sons, Inc., Chicago.

Program

WEDNESDAY, MAY 8 (Cont.)

12:00 PM (B)—Malleable Round Table Luncheon.
(Sponsored by Malleable Division)

Presiding—J. H. Lansing, Malleable Founders' Society, Cleveland.

Co-Chairmen—A. M. Fulton, Northern Malleable Iron Co., St. Paul, Minn.; and K. H. Hamblin, Columbia Malleable Castings Corp., Columbia, Pa.

"Atmosphere Indicators in Melting."

"Single and Double Burner Use in Melting."

"Use of Large End Test Bars."

"Sulphur-Manganese Ratios and the Effect on Other Elements."

2:00 PM (A)—Sand Research.
(Sponsored by Foundry Sand Research Project, Technical Development Program)

Presiding—B. H. Booth, Carpenter Bros., Inc., Milwaukee.

Co-Chairman—R. E. Morey, Naval Research Laboratory, Washington, D. C.

"The A.F.A. Clay and Fineness Determinations Can Be Quantitative"—By D. C. Williams, A.F.A. Research Fellow, Cornell University, Ithaca, N. Y.

"The Fineness Tests of Molding Sands"—By A. I. Krynitsky and Margaret Price, Bureau of Standards, Washington, D. C.

"The Behavior of Molding Materials in Their Own Atmosphere at Elevated Temperatures"—By H. W. Dietert and Robert L. Doelman, Harry W. Dietert Co., Detroit.

2:00 PM (B)—Steel.
(Sponsored by Steel Division)

Presiding—H. H. Blosjo, Minneapolis Electric Steel Castings Co., Minneapolis.

Co-Chairman—Charles Locke, West Michigan Steel Castings Co., Muskegon, Mich.

"Bore Cracks in Cast Steel Valves and Fittings"—By H. F. Bishop, Naval Research Laboratory, Washington, D. C., and H. F. Taylor, Massachusetts Institute of Technology, Cambridge, Mass.

"Homogenization Heat Treatment of Cast Steel"—By P. C. Rosenthal and J. G. Kura, Battelle Memorial Institute, Columbus, Ohio.

"Thermal Relief of Stresses in Steel Castings and Weldments"—By C. R. Jelm and S. A. Herres, Watertown Arsenal, Watertown, Mass.

"Committee Report on Heat Treatment of Steel Castings"—By E. R. Young, Climax Molybdenum Co., Chicago.


V. J. Sedlon


T. E. Eagan


J. W. Juppenlatz


Phil Carroll, Jr.

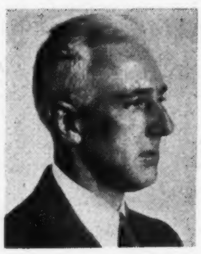

W. W. Levi


H. W. Lownie, Jr.


C. W. Wade


R. F. Fisher


J. H. Hall

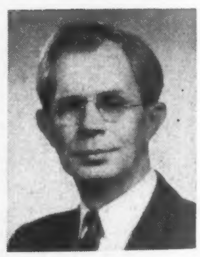

J. E. Goss


J. B. Caine


H. C. Winte


J. S. Vanick


J. A. Rassenfoss


Ralph L. Lee


C. W. Briggs


Julius A. Griffin


William E. Jones

G. P. Halliwell

R. P. Stevens

B. M. Loring

W. H. Rother

R. G. Ferrell

G. A. Lillieqvist

R. H. Brouk

T. D. Stay

K. H. Priestly

WEDNESDAY, MAY 8 (Cont.)

2:00 PM (C)—Symposium on Engineering Properties of Gray Iron.

(Sponsored by Engineering Properties Committee, Gray Iron Division)

Presiding—R. G. McElwee, Vanadium Corp. of America, Detroit.

Co-Chairman—W. E. Mahin, Armour Research Foundation, Illinois Institute of Technology, Chicago.

"The Ductility and Elasticity of White and Gray Irons"—By R. A. Flinn and H. J. Chapin, American Brake Shoe Co., Mahwah, N. J.

"Gray Cast Iron Tensile Strength, Brinell Hardness and Composition Relationships"—By T. E. Barlow and C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio.

"Effect of Carbon Equivalent and Section Size on Physical Properties of Gray Iron"—By K. Geist, Allis-Chalmers Mfg. Co., Milwaukee.

"Structural Control for Wear Resistance"—By F. G. Sefing, International Nickel Co., New York.

"Practical Considerations Affecting the Section Sensitivity of Gray Iron when Applied to Actual Castings"—By H. C. Winte, Worthington Pump & Machine Corp., Buffalo, N. Y.

Program

2:00 PM (D)—Gray Iron Shop Course (Session 3).

(Sponsored by Gray Iron Division, Gray Iron Shop Course Committee)

Presiding—T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio.

Co-Chairman—W. B. McFerrin, Electro Metallurgical Co., Detroit.

"Casting Defects Attributable to Metal"—A.F.A. Committee on Analysis of Castings Defects.

4:00 PM—Lecture Course (Session 3).

(Sponsored by Annual Lecture Committee)

Presiding—H. M. St. John, Crane Co., Chicago.

Co-Chairman—C. O. Thieme, H. Kramer & Co., Chicago.

Subject—*"Brass and Bronze Foundry Control."*

Discussion Leader—D. Frank O'Connor, American Saw Mill Machinery Co., Hackettstown, N. J.

6:00 PM—Foundry Instructors' Dinner.

(Sponsored by Committee on Cooperation with Engineering Schools)

Presiding—P. E. Kyle, Massachusetts Institute of Technology, Cambridge, Mass.

8:00 PM (A)—Foreman Training.

(Sponsored by Committee on Foreman Training)

Presiding—F. E. Wartgow, A.F.A., Chicago.

"Engineer of Human Relations"—By Steven G. Garry, Caterpillar Tractor Co., Peoria, Ill.

8:00 PM (B)—Engineering Student Training.

(Sponsored by Committee on Cooperation with Engineering Schools)

Presiding—G. J. Barker, University of Wisconsin, Madison, Wis.

Co-Chairman—C. J. Freund, University of Detroit.

Panel Discussion: *"College Graduates vs. Employers."*

8:00 PM (C)—Sand Shop Course (Session 3).

(Sponsored by Sand Shop Operation Course Committee)

Presiding—E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit.

Subject—*"Brass and Bronze Sand Control."*

Discussion Leader—W. M. Ball, Jr., Magnus Brass Div., National Lead Co., Cincinnati.

Program

Harold Warner

Oscar Blohm

H. E. Arblaster

R. J. Allen

M. D. Johnson

B. A. Miller

THURSDAY, MAY 9

8:30 AM (A)—Foundry Costs.

(Sponsored by Foundry Cost Committee)

Presiding—R. L. Lee, Grede Foundries, Inc., Milwaukee.

Subject—*"Small Shop Cost System."*

Discussion Leaders—Foundry Cost Committee Members.

8:30 AM (B)—Gray Iron Shop Course (Session 4).

(Sponsored by Gray Iron Division, Gray Iron Shop Operation Course Committee)

Presiding—E. J. Burke, Hanna Furnace Corp., Detroit.

Co-Chairman—P. T. Bancroft, Republic Coal & Coke Co., Moline, Ill.

Subject—*"The Metallurgy of Carbon Control in the Cupola"*—By Ralph A. Clark, Electro Metallurgical Co., Chicago.

9:30 AM—Annual Business Meeting.

Presiding—F. J. Walls, President, American Foundrymen's Association.

President's Annual Address.

Report on Election of Officers and Directors.

A.F.A. Foundation Lecture—*"Test Bars for 85 Copper—5 Tin—5 Lead—5 Zinc Alloy—Design and Some Factors Affecting Their Properties."* Presented by G. H. Clamer, Ajax Metal Co., Philadelphia.

12:00 PM (A)—Steel Round Table Luncheon.

(Sponsored by Steel Division)

Presiding—T. D. West, West Steel Casting Co., Cleveland.

Co-Chairman—E. C. Troy, Dodge Steel Co., Philadelphia.

Subject—*"General Discussion on Steel Foundry Practice."*

2:00 PM (A)—Brass and Bronze.

(Sponsored by Brass and Bronze Division)

Presiding—G. K. Dreher, Ampco Metal, Inc., Milwaukee.

Co-Chairman—A. K. Higgins, Allis-Chalmers Mfg. Co., Milwaukee.

"The Use of Insulating Pads and Riser Sleeves for Producing Sound Bronze Castings"—By H. F. Taylor and W. C. Wick, formerly Naval Research Laboratory, Washington, D. C.

"Knock-off Risers for Non-Ferrous Castings"—By Stanley W. Brinson and J. A. Duma, Norfolk Navy Yard, Portsmouth, Va.

"Sealing Bronze Pressure Castings Through Heat Treatment"—By F. L. Riddell, Naval Research Laboratory, Washington, D. C.

2:00 PM (B)—Patternmaking.

(Sponsored by Patternmaking Division)

Presiding—Frank C. Cech, Cleveland Trade School, Cleveland.

Co-Chairman—V. J. Sedlon, Master Pattern Co., Cleveland.

"The Use of Wood Models in Planning and Design"—By G. W. Schuller, Caterpillar Tractor Co., Peoria.

"Patterns as the Production Foundry Sees Them"—By Guy Pealer, Elmira Foundry Co., Inc., Elmira, N. Y.

2:00 PM (C)—Gray Iron.

(Sponsored by Gray Iron Division)

Presiding—T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.

Co-Chairman—R. J. Allen, Worthington Pump & Machinery Corp., Harrison, N. J.

"Microstructure Related to Properties of Cast Iron"—By W. E. Mahin and H. W. Lownie, Jr., formerly Westinghouse Electric Corp., East Pittsburgh, Pa.

"Cupola Operation and Control"—By W. W. Levi, Lynchburg Foundry Co., Radford, Va.

"Technical Organization of the French Foundry"—By A. Le Thomas, President, French Technical Committee of Foundry Industries—French exchange paper.

Program

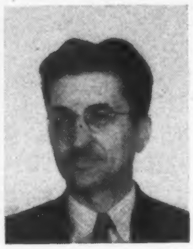
E. J. Carmody

E. C. Zirzow

Basil Gray

C. S. Reed

J. A. Blastic



O. Tichy

D. C. Williams

Werner Finster

Walter Bonsack

THURSDAY, MAY 9 (Cont.)

2:00 PM (D)—Job Evaluation and Time Study.
(Sponsored by Job Evaluation and Time Study Committee)

Presiding—Robert J. Fisher, Falk Corp., Milwaukee.
Co-Chairman—F. E. Wartgow, American Foundrymen's Association, Chicago.
"What Management Should Know About Timestudy"—By Phil Carroll, Jr., Maplewood, N. J.

4:00 PM (A)—Foundry Costs.
(Sponsored by Foundry Cost Committee)

Presiding—R. L. Lee, Grede Foundries, Inc., Milwaukee.
Co-Chairman—L. M. Nesselbush, Falcon Bronze Co., Youngstown, Ohio.
Subject—*"Current Foundry Problems and Fundamentals of Cost for Small Foundries."*
"Meeting Foundry Competition With a Sound Cost Program"—By A. E. Grover, Cleveland Heights, Ohio.

4:00 PM (B)—Apprentice Training.
(Sponsored by Apprentice Training Committee)

Presiding—F. C. Cech, Cleveland Trade School, Cleveland.
Co-Chairman—W. J. Hebard, Continental Foundry & Machine Co., East Chicago, Ind.
Panel Discussion:
"Standard Apprentice Training"—By Carl F. Haertel, Falk Corp., Milwaukee.
"Accelerated Training Program"—By W. J. Hebard, Continental Foundry & Machine Co., East Chicago, Ind.
"Upgrading Systems"—By M. J. Gregory, Peoria, Ill.
"Veteran Training"—By W. M. Owen, Caterpillar Tractor Co., Peoria, Ill.
"General Summary"—By C. J. Freund, University of Detroit, Detroit.

4:00 PM (C)—Lecture Course (Session 4).
(Sponsored by Annual Lecture Committee)

Presiding—John Howe Hall, General Steel Castings Corp., Eddystone, Pa.
Co-Chairman—C. E. Sims, Battelle Memorial Institute, Columbus, Ohio.
"Steel Foundry Control"—By G. A. Lillieqvist, American Steel Foundries, East Chicago, Ind.

6:45 PM—Apprentice Training Dinner.
(Sponsored by Apprentice Training Committee)

Presiding—C. W. Wade, Caterpillar Tractor Co.
Speaker—J. E. Goss, Brown & Sharpe Mfg. Co., Providence, R. I.—*"A Means to Produce Skilled and Leadership Personnel."*

7:00 PM—A.F.A. Alumni Dinner.

Presiding—Ralph J. Teetor, Cadillac Malleable Iron Co., Cadillac, Mich.

8:00 PM (A)—Sand Shop Course (Session 4).
(Sponsored by Sand Shop Operation Course Committee)

Presiding—E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit.
Subject—*"Gray Iron Sand Control."*
Discussion Leaders:
H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y.
T. W. Curry, Lynchburg Foundry, Lynchburg, Va.

8:00 PM (B)—Job Evaluation and Time Study.
(Sponsored by Job Evaluation and Time Study Committee)

Presiding—Robert J. Fisher, Falk Corp., Milwaukee.
Co-Chairman—F. E. Wartgow, American Foundrymen's Association, Chicago.
Panel Discussion by Committee—*"Time Study and Job Evaluation."*

8:00 PM (C)—Apprentice Training.
(Sponsored by Apprentice Training Committee)

Presiding—C. W. Wade, Caterpillar Tractor Co., Peoria, Ill.
Co-Chairman—M. J. Gregory, Peoria, Ill.
"Passing On the Know-How"—By R. L. Lee, General Motors Corp., Detroit.

Program

FRIDAY, MAY 10

9:30 AM—Sand Shop Course (Session 5).
(Sponsored by Sand Shop Operation Course Committee)

Presiding—R. H. Jacoby, Key Co., East St. Louis, Ill.
Subject—*"Steel Foundry Sand Control."*
Discussion Leader—E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit.

10:00 AM (A)—Gray Iron.
(Sponsored by Gray Iron Division)

Presiding—H. Bornstein, Deere & Co., Moline, Ill.
Co-Chairman—V. A. Crosby, Climax Molybdenum Co., Detroit.
"Effect of Heat Treatment on the Endurance Limit of Alloyed Gray Cast Iron"—By T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.
"Engineering Properties of Heat Treated Cast Irons"—By J. S. Vanick, International Nickel Co., New York.
Discussion of Charts, *"Cupola Operations Handbook"*—By R. G. McElwee, Vanadium Corp. of America, Detroit.
"Theories of Gray Cast Iron Inoculation"—By H. W. Lownie, Jr., formerly Westinghouse Electric Corp., East Pittsburgh, Pa.

10:00 AM (B)—Steel.
(Sponsored by Steel Division)

Presiding—C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio.
Co-Chairman—J. A. Rassenfoss, American Steel Foundries, East Chicago, Ind.
"Preliminary Investigation of Methods for Control of Hardenability at the Furnace"—By G. Vennerholm, Ford Motor Co., Dearborn, Mich.
"Methods of Quality Control in the Foundry"—By J. W. Juppenlatz, Lebanon Steel Foundry, Lebanon, Pa.
Committee Report—*"Production of Steel for Castings"*—By C. E. Sims, Battelle Memorial Institute, Columbus, Ohio.
"Conventional Versus Washburn Risers for Steel Castings"—By W. E. Jones, American Steel Foundries, Bettendorf, Iowa.

2:00 PM (A)—Steel.
(Sponsored by Steel Division)

Presiding—J. W. Juppenlatz, Lebanon Steel Foundry, Lebanon, Pa.
Co-Chairman—J. B. Caine, Sawbrook Steel Castings Co., Cincinnati.
"Low Temperature Properties of Certain Steels"—By C. E. Sims and F. W. Boulger, Battelle Memorial Institute, Columbus, Ohio.
"The Production of Grand Slam Bomb Castings"—By Basil Gray, English Steel Corp., Sheffield, England—Institute of British Foundrymen Exchange Paper.
"The Susceptibility of Steel to Hot Tear Formation in Casting"—By N. B. Gelperin, Moscow Div., State Institute, "Giprotjagmashe," Moscow, U.S.S.R.
"The Technological Principles of Casting Design"—By Victor M. Shestopal, Stalin Machine Tool Institute, Moscow, U.S.S.R.
"Committee Report on Non-Destructive Testing"—By C. W. Briggs, Steel Founders' Society of America, Cleveland.

2:00 PM (B)—Gray Iron Welding.
(Sponsored by Gray Iron Division)

Presiding—E. C. Jeter, Ford Motor Co., Dearborn, Mich.
Co-Chairman—John Crowe, Air Reduction Sales Co., New York.
"Metallurgical Aspects of Repair Welding of Gray Iron"—By J. A. Blastic, Detroit Diesel Div.; J. A. Griffin, Pontiac Motor Div.; and J. M. Diebold, General Motors Truck and Coach Div., General Motors Corp., Detroit.
"Physical Aspects of Welding Gray Iron Castings"—By W. Pfander, Ford Motor Co., Dearborn, Mich.
"Welding Heavy Gray Iron Sections"—By L. J. Larsen, Allis-Chalmers Mfg. Co., Milwaukee.

2:00 PM (C)—Brass and Bronze.
(Sponsored by Brass and Bronze Division)

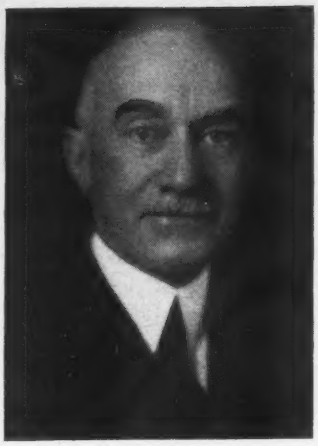
Presiding—G. P. Halliwell, H. Kramer & Co., Chicago.
Co-Chairman—A. H. Hesse, R. Lavin & Sons, Chicago.
"Distribution of Mechanical Properties in Sand Cast Bronzes"—By R. H. Brouk, R. G. Hardy, and B. M. Loring, Naval Research Lab., Washington, D. C.
Committee Report on *"Manganese Bronze"*—By G. K. Dreher, Ampco Metal, Inc., Milwaukee.
"Manganese Bronze"—By H. E. Arblaster, Institute of Australian Foundrymen Exchange Paper.

4:00 PM—Lecture Course (Session 5).
(Sponsored by Annual Lecture Committee)

Presiding—W. H. Rother, Buffalo Foundry & Machine Co., Buffalo, N. Y.
Co-Chairman—J. S. Vanick, International Nickel Co., New York.
Subject—*"Gray Iron Foundry Control."*
Discussion Leader—W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee.

7:00 PM—Annual Dinner.

Presiding—F. J. Walls, President, A.F.A.
Presentation of A.F.A. Gold Medal Awards and Honorary Life Memberships.
Speaker—Brig. Gen. Donald Armstrong, Commandant, Army Industrial College, Department of Research, Washington, D. C.



GUILLIAM CLAMER TO DELIVER ANNUAL FOUNDATION LECTURE

Dr. Guilliam H. Clamer,

President and General Manager of The Ajax Metal Co., Philadelphia, will present the 1946 A.F.A. Foundation Lecture, programmed for the Annual Business Meeting session, Thursday, May 9, of the Golden Jubilee Foundry Congress. As his subject Dr. Clamer has chosen "Test Bars for 85 Copper, 5 Tin, 5 Lead, 5 Zinc Alloy—Design and Some Factors Affecting Their Properties."

A.F.A. Past President and Gold Medalist, Dr. Clamer, internationally recognized as an outstanding authority on the chemistry, melting and casting of non-ferrous alloys, was the unanimous selection of the Association's Annual Lecture committee of which H. M. St. John, Crane Co., Chicago, is chairman.

The 1946 Foundation Lecture, fourth in a series inaugurated at the Association's 47th Annual Meeting in 1943, will report on an extended research on test bars and test bar practice, as applied to 85-5-5-5, conducted at Battelle Memorial Institute under the sponsorship of the Non-Ferrous Ingot Metal Institute. The project, expected to aid in developing practice and standards for a determination of melt quality, indicated that a test bar may be used only to determine melt quality.

Native Philadelphian and one-time associate of Dr. F. A. Genth, one of the most noted of America's mineral chemists, Dr. Clamer was graduated from the University of Pennsylvania in 1897 with a bachelor of science degree in chemistry. His earlier courses at Philadelphia's Manual Training School, then one of the two high schools in the city fitted him well, he points out, for entry into the foundry, metallurgical and electrical fields to which his career has been confined.

Upon his graduation from the University of Pennsylvania, Dr. Clamer established a chemical laboratory at the Ajax Metal Co. Since, as far as could be determined, this was the first instance of a chemist being employed in the non-ferrous industry, he found a virgin field and one in which, he modestly states, "it was not hard to display usefulness."

In his earliest days in that laboratory Dr. Clamer analyzed competitors' alloys, searched for means of using scrap on a scientific rather than a guess basis, checked purchases and product and controlled manufacturing processes. Then he turned his attention to the development of non-ferrous alloys and brought out several new series, including high strengths and specials for specific applications.

Later, experimenting with ferrous alloys, he developed copper-nickel steels, which were used during World War I in the manufacture of shells and gun-carriage castings, and some high nickel-copper alloys designed for corrosion resistance. For his invention, in 1901, of a scrap refining process he was awarded the Elliott Cresson Gold Medal of the Franklin Institute.

His interest in an invention of Dr. Carl Hering, brother of his teacher in electricity at the Manual Training School, led Dr. Clamer into the electric furnace field where research culminated in the development of an induction furnace which revolutionized melting practice in brass mills of this and other countries and found widening use in foundry melting of brass alloys. Later research in conjunction with Dr. Edwin F. Northrup of Princeton University developed a coreless, high-frequency power operated induction furnace used extensively in the melting of alloy steels.

Three technical societies, the A.F.A., the American Institute of Metals and the American Society for Testing Metals, have honored Dr. Clamer by election to their highest office, the presidency. He was president of A.F.A. in 1923 and a director of the Association for three years thereafter.

First non-ferrous member of A.S.T.M., Dr. Clamer was influential in the formation of its first non-ferrous committees. On them he has a long record of service, including periods as the official representative of both the A.F.A. and the Non-Ferrous Ingot Metal Institute.

A member of the managing board of Franklin Institute for many years and a past-president of its mining and metallurgical section, Dr. Clamer is chairman of the Institute's Committee on Bartol Research Foundation, which is devoted to nuclear physics and cosmic ray researches, and chairman of its committee on laboratories for research and development.

For his many and valuable contributions to the castings industry and, particularly, for his distinguished work in the field of non-ferrous metallurgy, Dr. Clamer was awarded the Joseph S. Seaman Gold Medal of the A.F.A. at the Association's 1933 Chicago convention.

Citations

FOR OUTSTANDING SERVIC TO

Hyman Bornstein

Peter Blackwood

Howard F. Taylor

To HYMAN BORNSTEIN

The Wm. H. McFadden Gold Medal . . .

"for his many and outstanding contributions to the foundry industry, particularly in the field of gray cast iron."

★

To PETER BLACKWOOD

The John H. Whiting Gold Medal . . .

"for his development work in, and his influence on, the free interchange of information pertaining to centrifugal castings."

★

To HOWARD F. TAYLOR

The Peter L. Simpson Memorial Medal . . .

"for his unfailing interest in, and contributions to, foundry research, and for his influence on the broadening of naval research in the field of cast metals."

★

To HAROLD JAMES ROAST

Honorary Life Membership . . .

"in recognition of his many and long continued contributions to the literature and cooperative enterprise of the foundry industry, both in the United States and Canada."

★

To WILLIAM J. COANE

Honorary Life Membership . . .

"because of his long and continued service to the industry, and in recognition of the fact that, as one of the few living men who attended the first convention of A.F.A. at Philadelphia in 1896, he has remained continuously active in the industry."

Harold J. Roast

Wm. J. Coane

BIOGRAPHIES

...ICE TO THE INDUSTRY

A.F.A. MEDALISTS 1924-45

1924— John Howe Hall
*Enrique Touceda
1925—*Richard Moldenke
Robert John Anderson
1926— Thomas Turner (England)
*John Shaw (England)
*E. V. Ronceray (France)
1927—*Robert Alexander Bell
1928—*Alexander E. Outerbridge, Jr.
1929—*Jesse Lee Jones
1930— Dr. Harry A. Schwartz
1931—*Ralph S. MacPherran
1932—*La Verne W. Spring
Dr. Horace W. Gillett
1933— Dr. Guilliam H. Clamer
1934— Arnold Lenz
1935— Lawrence Lee Anthes
1936—*David McLain
Dr. Heinrich Ries
1937— John Ward Bolton
Charles Willers Briggs
Dr. James Tucker MacKenzie
1938—*Frederick Ayres Lorenz, Jr.
1939—*Donald James Campbell
Harold Sands Falk
James Ramsay Allan
1940— Frederick Ketchum Vial
Nathaniel K. B. Patch
Harry Walter Dietert
Frederick A. Melmoth
1941— Donald James Reese
Max Kuniansky
Frederick Louis Wolf
Charles Edgar Hoyt
1942— Alfred L. Boegehold
John E. Galvin
1943— Rufus F. Harrington
Carl F. Joseph
1944— Alfred W. Gregg
William G. Reichert
1945— Robert Edwin Kennedy
Charles Edgar Sims

*Deceased.

HYMAN BORNSTEIN, Director of Testing and Research Laboratories for Deere & Co., Moline, Ill., and a past President of A.F.A., will be justly recognized at the 50th Anniversary Convention by receiving the William H. McFadden Gold Medal of the Association *"for his many and outstanding technological contributions to the foundry industry, particularly in the field of gray cast iron."*

Recognized internationally as one of the nation's leading metallurgists, and a leading authority on cast iron, Mr. Bornstein has long been most active in the Association's technical affairs, and has served continuously on many committees of this and other technical societies. A National Director of A.F.A. 1932-1935, he was elected National President in 1937. At various times he has served as Chairman of the Gray Iron Division and as chairman or member of other ferrous committees, member of the Committee on Liquid Shrinkage Investigation of Metals Advisory to the Bureau of Standards; member, Ferrous Metals Committee Advisory to the Bureau of Standards; chairman, Alloy Iron Committee, and American Foundrymen's Association representative on many others.

Born in Chicago in 1891, he attended the former Armour Institute of Technology and graduated in 1911 with a B.S. degree in Chemical Engineering. Taking up the study of law, he graduated from John Marshall Law School, Chicago, in 1915 with an LL.B. degree. He held positions as chemist for the Union Pacific RR., Swift & Co., and the City of Chicago, before entering military service in World War I as a Captain of Ordnance. Ever since the war, he has been associated with Deere & Co.

Chairman of the former Quad City Foundrymen's Association, he played an active part in organizing that group as the Quad City Chapter of A.F.A. and is still active in its work. In addition to being a member of A.F.A., he also holds membership in, and has served on numerous committees of A.S.T.M., A.S.M., American Society of Mechanical Engineers and American Chemical Society.

PETER BLACKWOOD, who started the foundry of Ford Motor Co. of Canada Ltd., at Windsor, Ontario, in 1936, and still is located there, will receive the John H. Whiting Gold Medal of A.F.A. at the Cleveland Convention *"for his developmental work on centrifugal castings and his influence on the free interchange of research data."*

Mr. Blackwood was born in Scotland and received his formal education at the Royal Technical College of Glasgow in metallurgy, metallography, foundry practice, chemistry, mining and geology. Upon entering industry, he obtained broad experience in blast furnace, open hearth and by-product operations in plants of Western Scotland.

Coming to North America, he extended his knowledge of metal processes to include electric furnace, converter and Brackelsberg furnace practice both in the United States and Canada. For 11 years he held the position of Superintendent of Foundries at the Buick and Pontiac divisions of General Motors Corp. While at Buick he delivered weekly lectures on foundry practice,

heat treatment and general metallurgy at the General Motors Institute of Technology.

At Ford he conducted a great deal of experimental and production work on the centrifugal casting process, and a paper co-authored by Mr. Blackwood and John Perkins on this subject before the 1944 Convention of A.F.A. in Buffalo, N. Y., excited widespread comment and was instrumental in directing the attention of many foundrymen to the advantages of the process. It is largely for his stimulation of broader foundry work on centrifugal castings and for his influence in making visitors welcome to inspect the Ford plant in Canada, that the John H. Whiting medal is being bestowed upon him.

HOWARD F. TAYLOR, formerly of the Naval Research Laboratory, Washington, D. C., and now Research Associate at Massachusetts Institute of Technology, Cambridge, Mass., will be awarded the Peter L. Simpson Memorial Medal of AFA at the 50th Anniversary Convention *"for his unfailing interest in and contributions to foundry research, and for his influence on the broadening of naval research in the field of cast metals."*

Through his work at the Naval Research Laboratory, Mr. Taylor has been of greatest value to the foundry industry in his sponsorship of research work on various types of cast metals, and as a result the Laboratory has participated actively in the A.F.A. Foundry Sand Research Project. Many important research projects on cast metals have been carried on by the Navy under the direction of Mr. Taylor, especially during the war years, and a tremendous amount of valuable data have been made completely available to foundrymen everywhere.

Howard Taylor's research interest and activities have covered many phases of cast metals. He carried on considerable work on mold atmospheres, particularly with silica sands for steel. Having associated metal penetration with mold atmospheres, he passed this information on to the industry freely. Under his direction the Laboratory foundry developed an all-purpose molding sand used at advanced naval repair bases and on shipboard, adaptable for all cast metals and useable even by novice molders.

A native of Michigan, Mr. Taylor was born at Leslie, Mich., in 1913 and graduated from Michigan State College, Lansing, with B.S. and M.S. degrees. On leaving college he became employed with the State Highway Dept. of Michigan, then became an instructor at his alma mater, first in the foundry and later in the metallurgical department.

After leaving the college, he took a position as chemist with the Michigan Sugar Co., which position he held before joining the staff of the Naval Research Laboratory, Washington, D. C. Last Fall he took a leave of absence in order to pursue advanced studies in metallurgy at Massachusetts Institute of Technology.

He has shown great interest in the training of research workers and in obtaining their interest in the cooperative activities of the foundry industry, and has served as a Director, Vice-Chairman and Chairman of the Chesapeake Chapter. He is a member of AFA, AIME, ASM, Institute of Metals (British), Society of Naval Engineers, Washington Society of Engineers, and last Fall was granted a Research Fellowship at M.I.T. by the Gray Iron Founders Society.

HAROLD JAMES ROAST, elected an Honorary Life Member of A.F.A. *"in recognition of his many and long continued contributions to the literature and cooperative enterprise of the foundry industry, both in the United States and Canada,"* is Vice-President, Canadian Bronze Co. Ltd. and subsidiaries, and is owner of Roast Laboratories of Montreal, Quebec. A National Director of A.F.A. 1940-1943, he has maintained a continuous activity in technical societies and the literature of the metalworking industries for over 20 years, both in Canada and in the United States.

Born in London, England, in 1882, he was educated under the Henry VIII Foundation at Berkhampstead and at the City of London College, of which he is a graduate. Coming to Canada in 1902, he quickly became connected with the foundry industry as chemist with Milton Hersey Co., Montreal, and has retained foundry connections ever since. Among the firms with whom he has been associated are: Canada Iron Foundries; Radnor Forges, Quebec (1903); Canadian Carbonate Ltd., Montreal (1904); Canadian Magnesite Co., Montreal and Newark, N. J. (1907); James Robertson Co. Ltd., Montreal (1914); National Bronze Co. Ltd., Montreal (1922); Robert Mitchell Co. Ltd. (1928), and Canadian Bronze (1933).

Mr. Roast has long been a voluminous contributor to scientific journals on technical subjects, and to the public press as well on matters of general interest. His writings have been presented in publications of A.F.A., A.I.M.E., A.S.M., Montreal Metallurgical Society, Chemical Association of McGill University at Montreal, Engineering Institute of Canada, Insurance Institute of Montreal, etc. His lifelong interest in educational work is indicated by 18 years as sessional lecturer at McGill.

Vice-Chairman of the Canadian section of A.F.A. before the formation of Canadian Chapters, he later became President of the Eastern Canada & Newfoundland Chapter. He also served as Chairman of the A.F.A. Non-Ferrous Division.

Besides his long-standing membership in A.F.A., Mr. Roast is a Fellow of the Chemical Society of London, England, the Canadian Institute of Chemistry, and of Sigma Xi Fraternity at McGill.

WILLIAM J. COANE, Vice-President of Ajax Metal Co., Philadelphia, has been elected to Honorary Life Membership in the Association *"because of his long service to the industry, and in recognition of the fact that, although one of the few living men who attended the first convention of American Foundrymen's Association at Philadelphia in 1896, he has remained continuously active in the industry."*

Born in Philadelphia, Mr. Coane attended Friends School in that city, and finished his education at Central High School. He began the active labors of his

(Concluded on Page 87)

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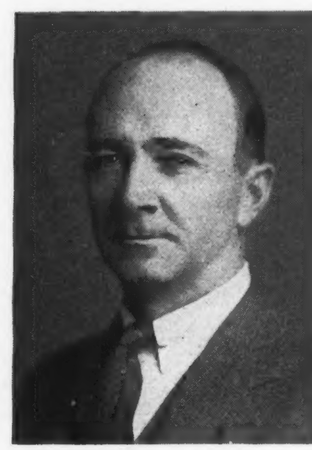

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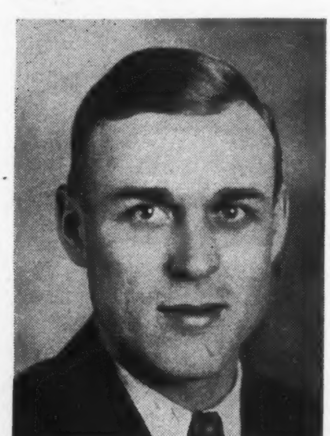

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Harry Reitinger

BIOGRAPHIES

(Continued from Page 84)

career when he became associated with the Jos. Dixon Crucible Co. of Jersey City, N. J., and served as manager of the company's Philadelphia division for twenty-six years. In 1912 he became Vice-President and Sales Manager of the Ajax Metal Co., a position he has held continuously until his recent retirement as Vice-President and Director.

Mr. Coane still holds the office of Vice-President of the C. Howard Hunt Pen Co., Camden, N. J., and is a Director of that firm. His contributions to business and community life have been outstanding, winning for him wide admiration and confidence.

For fifteen years Mr. Coane has been a member of the Executive Committee of the Non-Ferrous Ingot Metal Institute, Chicago, and for many years has represented that organization in the capacity of National Councilor in the Chamber of Commerce of U. S.

He is an original member of AFA, and has continued his affiliation for half a century. One of the few living men who attended the 1st Annual Convention of the Association in 1896, he was active in the local group whose efforts made that meeting successful.

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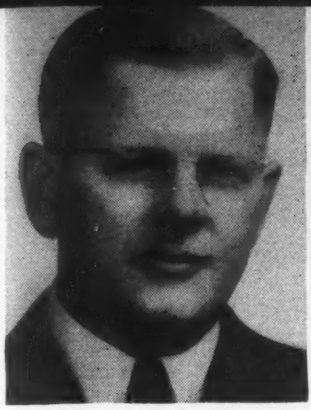

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C. A. Barnett, Foundry Equipment Co., Cleveland.

J. H. Bruce, Bowler Foundry Co., Cleveland.

Frank C. Cech, Cleveland.

F. J. Dost, Sterling Foundry Co., Wellington, Ohio.

L. M. Nesselbush, Falcon Bronze Co., Youngstown, Ohio.

H. M. Oehling, National Malleable & Steel Castings Co., Cleveland.

H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland.

Chas. Seelbach, Forest City Foundries Co., Cleveland.

FINANCE COMMITTEE

Chairman, F. Ray Fleig, Smith Facing & Supply Co., Cleveland.

Vice-Chairman, Homer Britton, Cleveland Co-operative Stove Co., Cleveland.

Thomas Dougherty, Dougherty Lumber Co., Cleveland.

R. T. Maneely, The Hoffman Bronze & Aluminum Co., Cleveland.

Wm. Chisholm II, Pickands, Mather & Co., Cleveland.

William E. Goebert, Bowler Foundry Co., Cleveland.

J. H. Tressler

Bruce Aiken

J. G. Goldie

PUBLIC AUDITORIUM
CLEVELAND, OHIO

1946 EXHIBITORS

MAY 6-10
INCLUSIVE

Acme Aluminum Alloys	Dayton, Ohio
Adams Co.	Dubuque, Iowa
Ajax Flexible Coupling Co.	Westfield, N. Y.
Ajax Engineering Corp.	Trenton, N. J.
Ajax Metal Co.	Philadelphia
Allis Chalmers Mfg. Co.	Milwaukee
Alloy Metal Abrasive Co.	Ann Arbor, Mich.
Aluminum Refiners Div. of Bohn Aluminum	Detroit
Air Reduction Sales	New York
American Air Filter Co., Inc.	Louisville, Ky.
American Chain Ladder & Co., Inc.	New York
American Crucible Co.	Shelton, Conn.
American Foundry Equipment Co.	Mishawaka, Ind.
American Gum Products Co.	New York
American Metal Market	New York
American Society for Metals	Cleveland
American Steel Abrasive Co.	Galion, Ohio
Apex Smelting Co.	Chicago
Arcade Manufacturing Co.	Freeport, Ill.
Asbury Graphite Mills	Asbury, N. J.
Atlas Publishing Co., Inc.	New York
Automatic Transportation Co.	Chicago
Ayers Mineral Co.	Zanesville, Ohio
Baker Industrial Truck Div., Baker-Raulang Co.	Cleveland
Barrett-Cravens Co.	Chicago
C. O. Bartlett & Snow Co.	Cleveland
Beardsley & Piper Co.	Chicago
Black, Sivalls & Bryson	Kansas City, Mo.
Blaw-Knox Co.	Pittsburgh, Pa.
Bloomsbury Graphite Co.	Bloomsbury, N. J.
Bradley Washfountain Co.	Milwaukee
Brickseal Refractory Co.	Hoboken, N. J.
Brush Beryllium Co.	Cleveland
Buckeye Products Co.	Cincinnati
Buffalo Forge Co.	Buffalo, N. Y.
Caldwell Co.	Rockford, Ill.
Campbell-Hausfeld Co.	Harrison, Ohio
Canadian Radium & Uranium Corp.	New York
Carborundum Co.	Niagara Falls, N. Y.
Edwin S. Carman, Inc.	Cleveland
Certified Core Oil & Mfg. Co.	Cicero, Ill.
Centrifugal Casting Machine Co.	Tulsa, Okla.
Chain Belt Co.	Milwaukee
Champion Foundry & Machine Co.	Chicago
Chicago Pneumatic Tool Co.	Chicago
Chicago Retort & Fire Brick Co.	Chicago
Chilton Co.	Philadelphia
Chisholm-Moore Hoist Corp.	Tonawanda, N. Y.
Clark Tructractor Co.	Battle Creek, Mich.
Clearfield Machine Co.	Clearfield, Pa.
Cleveland Flux Co.	Cleveland
Cleveland Pneumatic Tool Co.	Cleveland
Cleveland Vibrator Co.	Cleveland
Cleveland Wire Spring Co.	Cleveland
Climax Molybdenum Co., Inc.	New York
Coaltoter Conveyor Co.	Chicago
L. A. Cohn & Bro., Inc.	Chicago
Columbus McKinnon Chain Corp.	Tonawanda, N. Y.
Combined Supply & Equipment Co.	Buffalo, N. Y.
Conover Engineering Co.	Cleveland
Controlamix Co.	Milwaukee
Corn Products Sales Co.	New York
Crescent Machine Co.	Latonia, Ohio
The Frank L. Crobaugh Co.	Cleveland
Davenport Machine & Foundry Co.	Davenport, Iowa
Dayton Oil Co.	Dayton, Ohio
Delhi Foundry Sand Co.	Cincinnati
Delta Mfg. Co.	Milwaukee
Delta Oil Products Co.	Milwaukee
Wm. Demmler & Bros.	Kewanee, Ill.
Despatch Oven Co.	Minneapolis
Harry W. Dietert Co.	Detroit
Do-All Co.	Minneapolis
Dougherty Lumber Co.	Cleveland
Joseph Dixon Crucible Co.	Jersey City, N. J.
Duquesne Smelting Corp.	Pittsburgh, Pa.
Eastern Clay Products, Inc.	Eifort, Ohio
Eastman Kodak Co.	Rochester, N. Y.
Electric Controller & Mfg. Co.	Cleveland
Electro Metallurgical Co.	New York
Electro Refractories & Alloys Corp.	Buffalo, N. Y.
Elesco Smelting Corp.	Chicago
Elwell-Parker Electric Co.	Cleveland
Employers Mutual Liability Insurance Co.	Milwaukee
Fabreeka Products Co.	Boston
Federal Foundry Supply Co.	Cleveland
Federal Metal Co.	Cleveland
Federated Metals Div., American Smelting & Refining Co.	New York
Fellows Corp.	Milwaukee
Fen Machine Co.	Cleveland
Fisher Furnace Co.	Chicago
Forker Corp.	Cleveland
Foundry Equipment Co.	Cleveland
Foundry Equipment, Inc.	Coldwater, Mich.
The Foundry	Cleveland
Foxboro Co.	Foxboro, Mass.
Fox Grinders, Inc.	Pittsburgh, Pa.
Freeman Supply Co.	Toledo, Ohio
Fremont Flask Co.	Fremont, Ohio
Russell R. Gannon Co.	Cincinnati
General Grinding Wheel Corp.	Philadelphia
General Electric X-Ray Corp.	Chicago
Globe Steel Abrasive Co.	Mansfield, Ohio
Great Lakes Foundry Sand Co.	Detroit
Great Western Manufacturing Co.	Leavenworth, Kan.
Hardy Sand Co.	Evansville, Ind.
Harnischfeger Corp.	Milwaukee
Benjamin Harris & Co.	Chicago Heights, Ill.
Hercules Powder Co.	Wilmington, Del.
Herman Pneumatic Machine Co.	Pittsburgh, Pa.
Hickman Williams & Co.	Cleveland
Hill & Griffith Co.	Cincinnati
Hines Flask Co.	Cleveland
Hoffman Foundry Supply Co.	Cleveland

SEE NEXT PAGE FOR FLOOR PLANS

LIST OF EXHIBITORS (Cont.)

Houghland & Hardy, Inc. ....Evansville, Ind.
E. F. Houghton & Co. ....Philadelphia
Hydro-Blast Corp. ....Chicago

Illinois Clay Products Co. ....Chicago
Illinois Testing Laboratories, Inc. ....Chicago
Independent Pneumatic Tool Co. ....Chicago
Industrial Minerals Co. ....Lancaster, Ohio
Ingersoll-Rand Co. ....Phillipsburgh, N. J.
International Graphite & Electrode Co. ....St. Marys, Pa.
International Molding Machine Co. ....Chicago
International Nickel Co., Inc. ....New York
Interstate Smelting & Refining Co. ....Chicago
The Iron Age....New York

Jeffery Manufacturing Co. ....Columbus, Ohio
Wm. F. Jobbins, Inc. ....Aurora, Ill.
Johns-Manville ....New York
The Johnston & Jennings Co. ....Cleveland

Kerkling & Co. ....Bloomington, Ind.
Kindt-Collins Co. ....Cleveland
Lester B. Knight & Associates....Chicago
Kolene Corp. ....Detroit
H. Kramer & Co. ....Chicago
Kuhlman Electric Co. ....Bay City, Mich.

Lauhoff Grain Co. ....Danville, Ill.
Lava Crucible Co. of Pittsburgh....Pittsburgh, Pa.
R. Lavin & Sons....Chicago
Lincoln Engineering Co. ....St. Louis
Link Belt Co. ....Chicago
Lithaloys Corp. ....New York

Macklin Co. ....Jackson, Mich.
Macleod Co. ....Cincinnati
Mall Tool Co. ....Chicago
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc. ....Passaic, N. J.
Manley Sand Co. ....Rockton, Ill.
Martindale Electric Co. ....Cleveland
Martin Engineering Co. ....Kewanee, Ill.
Master Tool Co. ....Cleveland

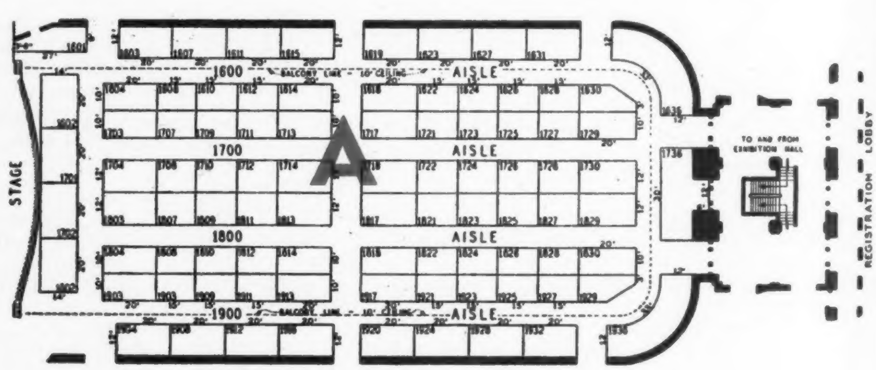
Mathews Conveyor Co. ....Ellwood City, Pa.
J. S. McCormick Co. ....Pittsburgh, Pa.
Metallizing Co. of America....Chicago
Michigan Smelting & Refining Div., Bohn Aluminum & Brass Co. ....Detroit
Milwaukee Foundry Equipment Co. ....Milwaukee
Mine Safety Appliances Co. ....Pittsburgh, Pa.
Miskella Infra-Red Co. ....Cleveland
Modern Equipment Co. ....Port Washington, Wis.
Molybdenum Corp. of America....Pittsburgh, Pa.
Monroe Tool & Mfg. Co. ....Monroe, Mich.

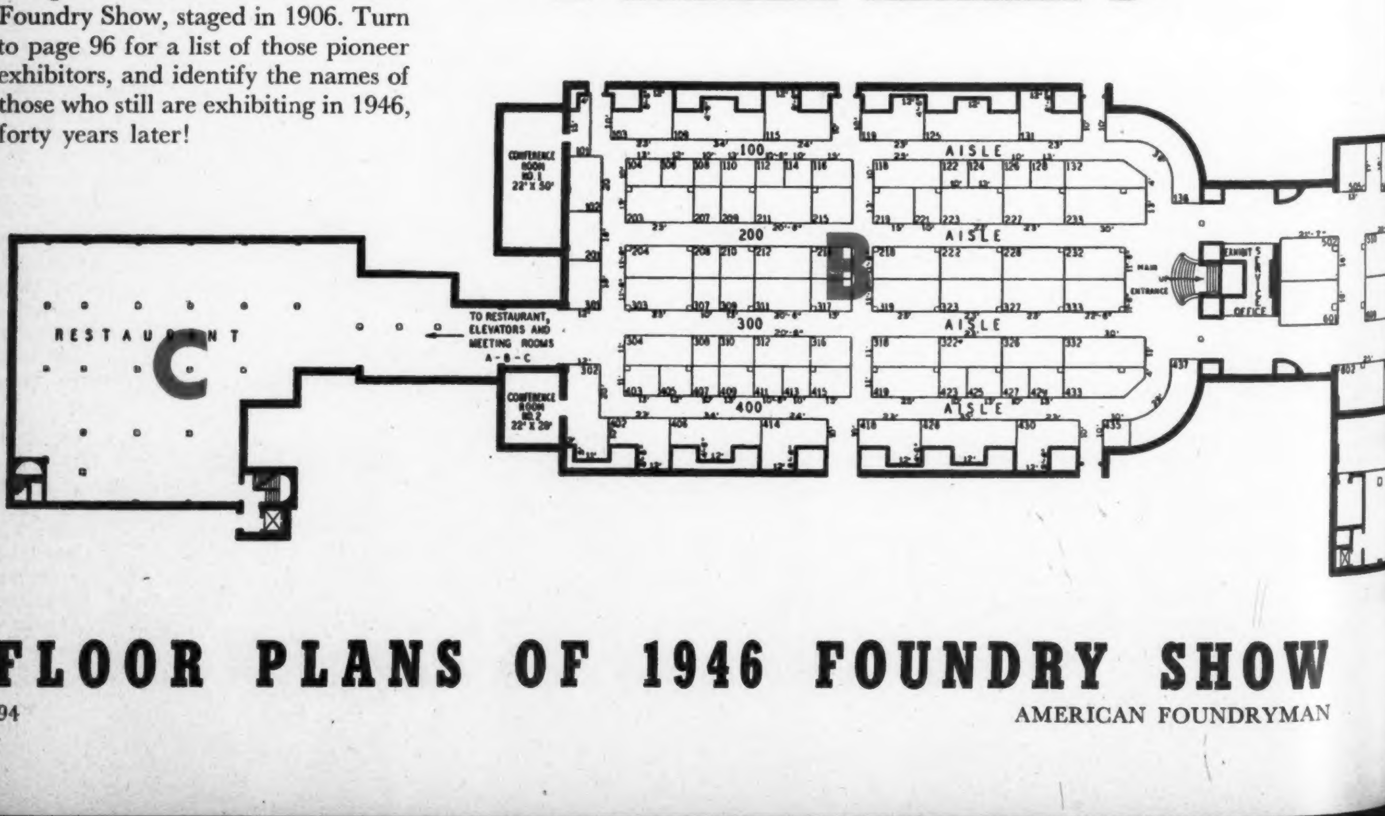
Nassau Smelting & Refining Co. ....New York
National Carbon Co. ....New York
National Engineering Co. ....Chicago
Newaygo Engineering Co. ....Newaygo, Mich.
Newark Pattern & Machine Co. ....Newark, Ohio
New Jersey Silica Sand Co. ....Millville, N. J.
Niagara Falls Smelting & Ref. Corp. ....Kenmore, N. Y.
Nichols Engineering & Research Corp. ....New York
Wm. H. Nicholls Co., Inc. ....Richmond Hill, N. Y.

(Continued on next page)

Golden Jubilee

ON THIS AND ACCOMPANYING PAGES are listed the names of over 260 progressive companies whose products and services will be on display at the Golden Jubilee Foundry Show. In considering the magnitude of this exhibit of the latest and most modern equipment, materials and supplies available for foundry use, it is interesting to hark back to the first Foundry Show, staged in 1906. Turn to page 96 for a list of those pioneer exhibitors, and identify the names of those who still are exhibiting in 1946, forty years later!





FLOOR PLANS OF 1946 FOUNDRY SHOW

The Exhibit Halls

Before attending the Golden Jubilee meeting, fix in your mind the location of the various exhibit halls.

A—The Arena (opposite page), located just off the Registration Lobby and on the same level. Non-operating exhibits and important service organizations. The Official A.F.A. Headquarters booth located here. Stairways and ramps to floors below. **Exhibit Booths Nos. 1600-1936, inclus.**

B—Auditorium Exhibit Hall (opposite page), immediately below the Arena. Reached most easily by Main Stairway, shown on plan. Non-operating, exhibits and service organizations, and some light-operating displays. **Exhibit Booths Nos. 100-435, inclus.**

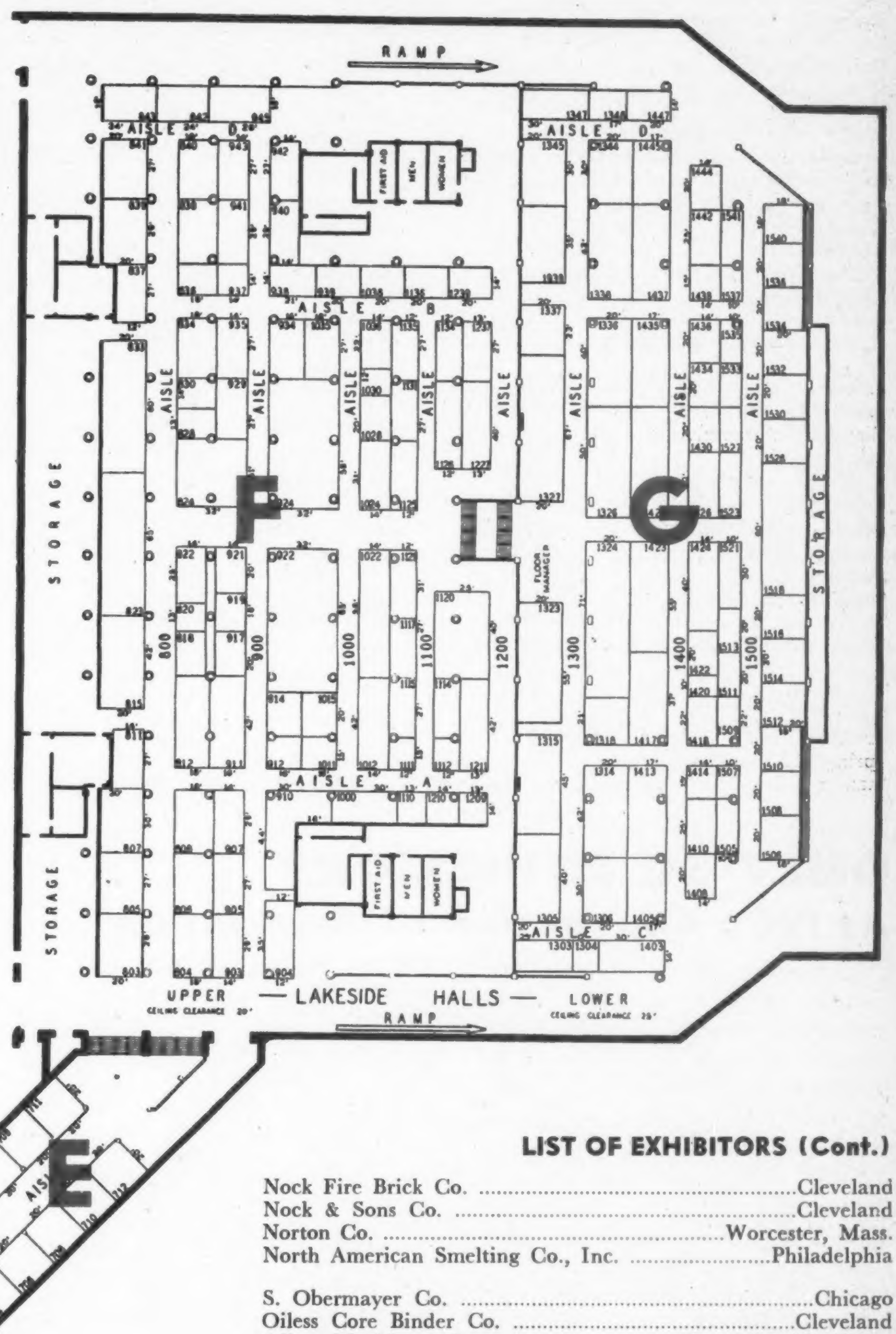
C—South Hall (opposite page), to South of Auditorium Exhibition Hall. Occupied by first-class Restaurant, serving luncheon every day, also dinner on May 7, Northeastern Ohio Day. No exhibit booths located here.

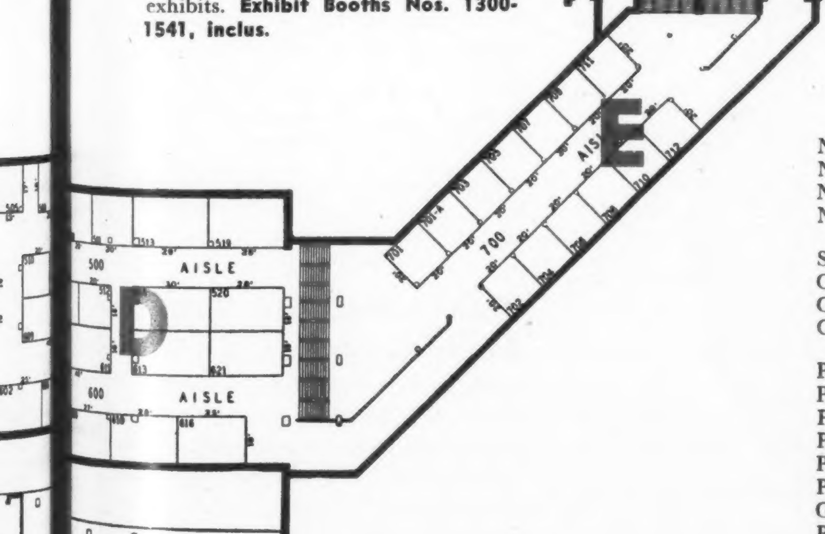
D—North Hall (opposite page and below), to North of Auditorium Exhibition Hall. Light-operating and non-operating displays. Service desks located here, at South end of the hall. A.F.A. Apprentice Contest entries located here. Main elevator to meetings in Grand Ballroom is reached off North Hall. **Exhibit Booths Nos. 500-621, inclus.**

E—Arcade (below, right), a few steps down from North Hall. Light-operating exhibits. Telephone lounge for long-distance calls at northern end. **Exhibit Booths Nos. 700-712, inclus.**

F—Lakeside Hall, Upper Level (right), a few steps down from Arcade. Location of heavy operating exhibits. **Exhibit Booths Nos. 800-1239, inclus.**

G—Lakeside Hall, Lower Level (extreme right), one flight down from Upper Level. Balance of heavy operating exhibits. **Exhibit Booths Nos. 1300-1541, inclus.**





LIST OF EXHIBITORS (Cont.)

Nock Fire Brick Co.	Cleveland
Nock & Sons Co.	Cleveland
Norton Co.	Worcester, Mass.
North American Smelting Co., Inc.	Philadelphia
S. Obermayer Co.	Chicago
Oiless Core Binder Co.	Cleveland
Oliver Machinery Co.	Grand Rapids, Mich.
Osborn Manufacturing Co.	Cleveland
Pangborn Corp.	Hagerstown, Md.
Parsons Engineering Corp.	Cleveland
Peerless Mineral Products Co.	Conneaut, Ohio
Peninsular Grinding Wheel Co.	Detroit
Penola, Inc.	Pittsburgh, Pa.
Penton Publishing Co.	Cleveland
George F. Pettinos, Inc.	Philadelphia
Pittsburgh Crushed Steel Co.	Pittsburgh, Pa.
Pittsburgh Lectromelt Furnace Corp.	Pittsburgh, Pa.

(Continued on next page)

FLOOR PLANS OF 1946 FOUNDRY SHOW

LIST OF EXHIBITORS (Concluded)

Pittsburgh Metals Purifying Co. ....Pittsburgh, Pa.
P. M. S. Co. ....Cleveland
Powermatic Ventilator Co. ....Cleveland
Purity Molding Sand Co. ....Dallas City, Ill.
Pyro Clay Products Co. ....Oak Hill, Ohio
Pyrometer Instrument Co. ....New York

Radium Chemical Co. ....New York
Ramtite Div., S. Obermayer Co. ....Chicago
N. Ranshoff, Inc. ....Cincinnati
Ready Power Co. ....Detroit
Redford Iron & Equipment Co. ....Detroit
Reliable Pattern & Castings Co. ....Cincinnati
Republic Coal & Coke Co. ....Chicago
Republic Structural Iron Works....................Cleveland
Robeson Process Co. ....New York
Robins Conveyors, Inc. ....Passaic, N. J.
Romph Furnace Co. ....Dearborn, Mich.
Rotor Tool Co. ....Cleveland
Royer Foundry & Machinery Co. ....Kingston, Pa.

Safety Clothing & Equipment Co. ....Cleveland
Sand Products Corp. ....Cleveland
Claude B. Schneible Co. ....Detroit
Schramm, Inc. ....West Chester, Pa.
F. E. Schundler & Co., Inc. ....Joliet, Ill.
Semet-Solvay Co. ....New York
Severance Tool Industries, Inc. ....Saginaw, Mich.
Shepard Niles Crane & Hoist Corp. ....Montour Falls, N. Y.
Simonds Abrasive Co. ....Philadelphia
Simplicity Engineering Co. ....Durand, Mich.
W. W. Sly Manufacturing Co. ....Cleveland
Smith Facing & Supply Co. ....Cleveland
Smith Oil & Refining Co. ....Rockford, Ill.
The Werner G. Smith Co. ....Cleveland
Spencer Turbine Co. ....Hartford, Conn.
SPO, Inc. ....Cleveland
Springfield Facing Co. ....Harrison, N. J.
Standard Conveyor Co. ....North St. Paul, Minn.

Standard Horse Nail Corp. ....New Brighton, Pa.
Standard Safety Equipment Co. ....Chicago
Standard Sand & Machine Co. ....Chicago
Steelblast Abrasives Co. ....Cleveland
Steel Shot & Grit Co. ....Boston
Sterling Wheelbarrow Co. ....Milwaukee
Frederic B. Stevens, Inc. ....Detroit
Stroman Furnace & Engineering Co. ....Chicago
Swan-Finch Oil Corp. ....New York
Syntron Co. ....Homer City, Pa.

Tabor Manufacturing Co. ....Philadelphia
Taggart & Co. ....Philadelphia
Tamms Silica Co. ....Chicago
Thiem Products Co. ....Milwaukee
Toledo Scale Co. ....Toledo, Ohio

Union Carbide & Carbon Co. ....New York
United Oil Mfg. Co. ....Erie, Pa.
United Compound Co. ....Buffalo, N. Y.
United States Electrical Tool Co. ....Cincinnati
United States Graphite Co. ....Saginaw, Mich.
United States Gypsum Co. ....Chicago
United States Hoffman Machinery Corp. ....New York
U. S. Reduction Co. ....East Chicago, Ind.

Vanadium Corp. of America....................New York
Velsicol Corp. ....Chicago
Vesuvius Crucible Co. ....Pittsburgh, Pa.

West Abrasives, Inc. ....Philadelphia
Western Metal Abrasives Co. ....Cleveland
Western Metal Co. ....Chicago
Whitehead Bros. Co. ....New York
Whiting Corp. ....Harvey, Ill.
Lee Wilson Engineering Co. ....Cleveland

Yale & Towne Mfg. Co. ....Philadelphia

Zanesville Sand Co. ....Zanesville, Ohio

ONLY 50 EXHIBITORS
At 1906 Convention of Association

THE FIRST full-fledged exhibit of foundry equipment and supplies staged in conjunction with the American Foundrymen's Association Convention was presented to the industry in 1906. This show was set up in the Central Armory . . . whose 120x207 ft. of space may be compared with the 50th Anniversary Foundry Show in the huge Cleveland Public Auditorium.

It is interesting to note that of the exhibitors who displayed their products at the 1906 Show included 15 who still are exhibiting with A.F.A., and 11 who again will be represented in 1946. The complete list of 1906 Exhibitors as recorded in *Journal of American Foundrymen's Association* for 1906 follows:

American Sand Co., Columbus, Ohio
Arcade Mfg. Co., Freeport, Ill.
Atlas Car & Mfg. Co., Cleveland
Ayers Mineral Co., Zanesville, Ohio
A. Brandau, Detroit
Berkshire Mfg. Co., Cleveland
L. K. Brown, Zanesville, Ohio
Bruce-Meriam Abbott Co., Cleveland
Buckeye Milling Co., Cleveland
Buckeye Sand Co., Pittsburgh, Pa.
Central Silica Co., Zanesville, Ohio
Chicago Pneumatic Tool Co., Cleveland
Chisholm & Moore Mfg. Co., Cleveland
Cleveland Chaplet Co., Cleveland
Cleveland Wire Spring Co., Cleveland
Connersville Blower Co., Connersville, Ind.
Crystal Fluor Spar Mining Co., Cleveland
E. A. Dempwolf & Sons, York, Pa.
Detroit Foundry Supply Co., Detroit
Diamond Clamp & Flask Co., Richmond, Ind.
William Dobson, Canastota, N. Y.
Electric Controller & Supply Co., Cleveland
Falls Rivet & Machine Co., Cuyahoga Falls, Ohio
Goldschmidt Thermit Co., Cleveland
Gordon Sand & Gravel Co., Cleveland
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Herman Pneumatic Machine Co., Zelienople, Pa.
Holland Linseed Oil Co., Chicago
Interstate Sand Co., Cleveland
W. W. Lindsay & Co., Philadelphia
Monarch Engineering Co., Baltimore, Md.
E. H. Mumford Co., Philadelphia
Ohio Sand Co., Conneaut, Ohio
Osborne Mfg. Co., Cleveland
Thomas W. Pangborn Co., New York
Republic Belting & Supply Co., Cleveland
W. W. Sly Mfg. Co., Cleveland
J. D. Smith Foundry Supply Co., Cleveland
Standard Sand & Machine Co., Cleveland
B. F. Sturtevant Co., Boston
Tabor Mfg. Co., Philadelphia
Taylor & Boggis Co., Cleveland
The Foundry, Cleveland
Wellman-Seaver-Morgan Co., Cleveland
Western Foundry Supply Co., East St. Louis, Ill.
Whiting Foundry Equipment Co., Harvey, Ill.
White Tool & Supply Co., Cleveland

Yearly Meeting Held By Radium Society

MEETING in the Grand Ballroom, Hotel Hollenden, Cleveland, the American Industrial Radium & X-ray Society held its Fifth Annual Convention, February 6-8. The sessions took place in conjunction with a symposium sponsored by Committee E-7 of the ASTM, and concurrently with the Annual Convention of the ASM and the National Metal Show.

PETER L. SIMPSON

Award Will Be Fifth A.F.A. Gold Medal

THE PETER L. SIMPSON gold medal of A.F.A., a new Association award, was made recently by the contribution of $5,000 of the National Engineering Co., Chicago, for endowment of an Award Fund that would make possible the honoring of current achievement within the industry.

Proffered to the Association by past President H. S. Simpson, the endowment was accepted by the A.F.A. Board of Directors and will be awarded for the first time at the 50th Anniversary Foundry Congress in Cleveland May 6-10.

The first recipient of the new medal is Howard F. Taylor, formerly of Naval Research Laboratory, and now Research Associate at Massachusetts Institute of Technology, Cambridge, Mass.

In accepting the generous offer of Mr. Simpson, the award agreement includes all of the general conditions associated with the John H. Whiting, John A. Penton, Wm. H. McFadden and Joseph S. Seaman medal awards which have been bestowed periodically by the Association since 1924. In one respect however, the Peter L. Simpson award will differ from the others in that it is intended that a medal shall be conferred each year upon some person "who shall, by his individual effort, achieve very noteworthy results toward the achievement of those objects for which the Association was formed."

Thus the purpose is to confer the annual award for meritorious accomplishment occurring during the year preceding each A.F.A. Annual Meeting. The decision as to achievements deemed worthy of recognition rests with the A.F.A. Board of Awards consisting of the last 7 living past presidents of the Association.

When past President H. S. Simpson, Chairman of the Board, National Engineering Co., tendered the new endowment fund, he did so as a memorial to his father, the late Peter L. Simpson. Its acceptance by unanimous action of the Board of Directors, was accompanied by the following motion:

"That A.F.A. accept with gratitude the generous offer of H. S. Simpson to endow an A.F.A. Memorial Fund in memory of the late Peter L. Simpson, and that a special committee of the Board is appointed to confer with the donor at the earliest possible date, to the end that the greatest good be accomplished for the foundry industry in honor of one of its outstanding pioneers."

Peter L. Simpson (1846-1917) was born in Scotland where he

Peter L. Simpson

served his foundry apprenticeship before coming to Canada at the age of 21. He worked first in a foundry at Petersborough, Ontario, and later in Toronto before entering the United States in the employ of the former Younglove Massey Company, Cleveland. While there, he was responsible for making the first steel castings manufactured west of the Alleghenies.

Mr. Simpson built and operated his own foundry in Cleveland for a number of years before becoming Foundry Superintendent of the former North Star Iron Works, Minneapolis. It was there that his inventive genius became apparent, resulting in production of the first gear molding machine, as well as the first dry press brick machine.

Travelled Widely

Moving to Chicago in 1889, he operated the National Brick Machinery Company and subsequently traveled to many parts of the world. Many of his developments in sand mixing equipment have been carried on by the National Engineering Company, Chicago, of which he was the first President.

Like many other self-educated men with a natural mechanical bent, Peter L. Simpson was long intensely interested in the spreading of greater knowledge among young men entering the industry and it is this interest which is typified on the Peter L. Simpson gold medal of A.F.A. which now bears his name.

Reproduction of the Peter L. Simpson Gold Medal of A.F.A., newest of the medals awarded by the Association for outstanding personal accomplishments on behalf of the castings industry.

50 YEARS OF PROGRESS IN CAST METALS

SPECIFICATIONS

John W. Bolton
Chief Metallurgist
The Lunkenheimer Co.
Cincinnati

Editor's Note—With the accompanying article, and others in this issue, A.F.A. commences the publication of a number of reviews covering "50 Years of Progress in the Foundry Industry." Outstanding foundry executives, metallurgists and operating men have been asked to prepare these reviews, pointing out the advancements made during the past half century in the arts and science of metal castings. Necessarily, some of these reviews must be strictly factual, whereas others must be general in nature depending upon the phase of foundry practice covered. Comments of readers and additional material, especially photographs of interest, are invited.

TODAY'S INCREASINGLY comprehensive materials specifications are a natural corollary of technological progress. To meet and exceed specifications requires scientific foundry controls and research development. Participation (individually, and through organizations such as the American Foundrymens' Association) in their formulation is desirable.

In the early Nineteenth century consumers showed but slight interest in mechanical tests. The little work conducted was carried on by scientists, who were handicapped by lack of knowledge of the chemistry and structural metallurgy of the materials studied.

Specifications Evolve

It was not until the latter part of the Nineteenth century that mechanical engineers, goaded by various materials failures, began to attempt materials testing and to resolve the data into constructional formulae. These data and formulae found their way into engineering text books and eventually into various codes and crude specifications. The foundryman, with but negligible knowledge of the engineering characteristics of the material he produced, frequently was unable to cooperate in or to criticize the efforts of the engineer. However, he was forced to develop and use some better quality controls.

Much of the basic science of physical metallurgy was developed in the earlier part of the present century. World War I stimulated translation of "theoretical" metallurgy into useful foundry methods and practices. Subsequent development of both theoretical and applied foundry metallurgy has been rapid.

Recognition of the need for sound test methods and for useable specifications led to organization of the American Society for Testing Materials in 1897.

Because of its earlier interest in specifications as referring to castings, the A.F.A. joined the A.S.T.M. as a charter member, thus recognizing the A.S.T.M. as a truly national specification making body.

The Association continued to work closely with A.S.T.M. until 1921, when a joint committee of the two societies proposed and adopted a resolution which provided that the A.F.A. recognize A.S.T.M. as a national specification making body, the A.F.A. having the privilege of official representation on all A.S.T.M. committees dealing with materials of interest to the foundry. This relationship between these two technical societies exists today. The A.S.T.M. was (and remains) unique in that both consumers and producers are adequately represented.

The first castings specifications, those for gray iron, were adopted in 1905. They remained without substantial change until 1932. The Navy Dept. Specification 46 I 6c-1940 retains the essential features of the 1905 specifications to this day.

Prior to 1905 the A.F.A. was active in standardization of analytical methods and also made available standard cast iron samples, such as are now prepared by the U. S. Bureau of Standards.

A.F.A. Men Active in A.S.T.M.

The A.S.T.M. Gray Iron Committee (later designated Committee A-3) always has had among its producer members, men active in the A.F.A. The A-3 roster of chairmen since 1905 includes Moldenke, an early Secretary of A.F.A.; Wood; McPherran, an A.F.A. Gold Medallist; Bornstein, an A.F.A. past-President; Rother; Bolton, A.F.A. Gold Medallist; and today, MacKenzie, another A.F.A. Gold Medallist.

For many years the Association also has had an "official representative" on A-3. At one period Bornstein was, simultaneously, chairman of both A-3 and the original A.F.A. Gray Iron Division Committee.

All the producer members of A-3 were members of the A.F.A. group. Naturally there were no problems of

coordination. The present National President of A.F.A., Fred J. Walls, is a member of A-3 and present chairman of one of its subcommittees. The A.F.A. is today officially represented by Messrs. Eagan, Kennedy, Mahin and Stuart. Some 40 per cent of the members at large on A-3 are A.F.A. workers.

In view of the 1905 specifications being inadequate for intelligent choice and prescription of gray irons according to section, a special A-3 subcommittee (including Bolton, Lowry and Mackenzie) drafted a resolution in 1929 as follows:

"Whereas it is realized that the present test bar indicates only the quality of iron in the ladle, and that the engineering and foundry fraternity needs more definite assurance of the properties of the metal in the casting, and further, that methods of taking tests directly from castings or from coupons attached thereto will lead to endless dispute within the trade, this committee recommends that methods of correlation be investigated. Among the methods suggested, consideration of the relationship between cooling rate and properties of iron of given analysis and thermal history seems promising. This may be expressed by the relation of volume to surface area. It is further recommended that a series of tests be devised to establish relations of various castings and test bars with equal volume to surface area ratio."

Many research papers were presented on this subject, to both A.F.A. and A.S.T.M., in the period 1926-32. A symposium on the physical properties of gray iron was presented before the A.S.T.M. in 1929. In 1933 the A.F.A. and A.S.T.M. cooperated in a symposium on specifications and testing methods, presented at the 1933 Annual Meeting of A.F.A.

Gray Iron Specifications

The newer type A-48 specifications, covering general gray iron where tensile strength is a consideration, was adopted in tentative form in 1932. At the present writing the following A.S.T.M. gray iron specifications are available:

*A-48-41—Gray Iron Castings.

A-126-42—Gray Iron Castings for Valves, Flanges and Pipe Fittings.

A-190-44-T, Gray Iron Castings, Light Weight and Thin Sectioned (tentative).

A-159-44-T, Gray Iron Casting, Automotive (tentative).

A-278-44-T, Gray Iron Castings for Pressure—Containing Parts for Temperatures up to 650° F. (tentative).

*A-44-41 Cast Iron Pit—Cast Pipe for Water or Other Liquids.

A-74-42—Cast Iron Soil Pipe and Fittings.

*A-142-38—Cast Iron Culvert Pipe.

A-247-41-T—Graphite in Gray Iron, Evaluation of Microstructure (tentative).

A-260-42-T—Torsion Tests of Cast Iron (tentative).

A-196-42-T—Cast Iron, Terms Relating To (tentative).

(Note: The recommended practice A-247 was prepared jointly by the A.F.A. Gray Iron Division and A.S.T.M. Committee A-3.)

World War II brought numerous federal and other consumer specification and testing problems acutely to the fore, and A.F.A. has organized a special committee to make an intensive study of these problems. This group already has assembled and considered a large number of American and foreign specifications in the light of recent developments.

Concurrent with newer developments in and applications of gray irons are numerous new prescriptions and methods of test that demand consideration. The A-48 specification is confined to those applications where tensile strength is the ruling factor. Certain of the other A.S.T.M. specifications were drawn up to cover only highly specific applications.

One result has been, in strictly consumer specifications, the setting up of additional prescriptions to meet real or fancied needs—and considerable difficulty, on part of the foundryman, in complying with some of the added requirements—occasionally perhaps unduly restrictive. The practical findings and research of the A.F.A. as a producer group will prove invaluable in the coordination and simplification of many specifications, and to the sound promotion of the products under consideration.

*Denotes approved as American Standard, by the American Standards Association.

The making of, and compliance with, specifications in cast metal has been one of the major factors in broadening the acceptance of the foundry product by designers of engineering assemblies. In this article John Bolton traces the development of specifications and their effect on quality control, and points out the relationship between A.F.A. and ASTM in the making of product standards.

First Steel Specifications

The first A.S.T.M. steel castings specifications were adopted in 1912. Prior to that time specifications for these products were largely straight consumer (not consumer-producer) type. The 1912 specifications provided for two classes: A, not heat treated; and B, annealed.

Class A was limited to 0.30 carbon, and 0.08 phosphorus. Class B was limited to 0.05 phosphorus, and 0.05 sulphur. Open hearth, crucible and "any other approved process" were recognized.

Class B castings called for the following minimum physicals:

	Hard	*Medium*	*Soft*
Tensile, psi.	80,000	70,000	60,000
Yield, psi.	36,000	31,500	27,000
Elongation in 2 in., per cent	15	18	22
Reduction of area, per cent	20	25	30

Today's specifications provide for higher yield, elongation, and reduction for a given tensile strength.

A.F.A. Steel Representation

A.S.T.M. Committee A-1 on Steel includes consideration of many wrought as well as cast products. The A.F.A. is represented by Sims: Chairman of Subcommittee VIII, Steel Castings, is Healey. Among other well known A.F.A. Steel Division members on VIII are Allen, Armstrong, Briggs, Campion, Finster, Gezelius, Hall, Jameson, Juppenlatz, Lillieqvist, MacKenzie, Riggan, Mahin, Smith, Young, Zeuge, and others.

Subcommittee XXII includes castings for elevated temperature service. A.F.A. members include Bolton, Briggs, Finster, Hall, Juppenlatz, Kanter, Malcolm and Riggan. A.F.A. members are included also on other subcommittees, including Advisory, Testing Methods, Heat Treatment, and Welding. (The A.F.A. also is represented on E-7, Radiographic Testing.)

The connections of the A.F.A. Steel Division with the A.S.T.M. and other specification making

bodies perhaps have not been quite as intimate as is the case with gray iron. Many A.F.A. papers are concerned with manufacturing practices designed to promote sound and economical castings. However, various research studies presented to the Association have had marked influence on specifications.

Present Steel Specifications

In 1912 there was one simple cast steel specification. In the A.S.T.M. there are available today the following:

A-27-44—Carbon-Steel Castings for Miscellaneous Industrial Uses.

A-87-44—Carbon-Steel and Alloy-Steel Castings for Railroads.

A-148-44—Alloy-Steel Castings for Structural Purposes.

A-128-33—Austenitic Manganese-Steel Castings.

A-95-44—Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service.

A-157-44—Alloy-Steel Castings for Valves, Flanges, and Fittings for Service at Temperatures from 750° to 1100° F.

A-215-44—Carbon-Steel Castings Suitable for Fusion Welding for Miscellaneous Industrial Uses.

A-216-44 T.—Carbon-Steel Castings Suitable for Fusion Welding for Service at Temperatures up to 850° F. (tentative).

A-217-44 T.—Alloy-Steel Castings Suitable for Fusion Welding for Service at Temperatures from 750° to 1100° F. (tentative).

A-221-39—Chromium Alloy-Steel Castings.

A-198-39—20 per cent Chromium, 9 per cent Nickel Alloy-Steel Castings.

A-222-39—Chromium-Nickel Alloy-Steel Castings.

A-223-39—Nickel-Chromium Alloy-Steel Castings.

Consumer pressure for details in cast steel specifications are numerous. Some of their demands are based on sound engineering needs. Others have no demonstrated basis.

Some Present Considerations

A pernicious consumer tendency is to attempt to prescribe total chemistry, minimum physicals, and detailed heat treatment. Since chemistry and heat treatment are determinants of the physicals, their detailed prescription should place responsibility for the physicals on the consumer.

The work of the Steel Castings Division on radiography and other non-destructive test methods has been useful in influencing specifications as well as in promoting improved foundry practices.

For years specification making bodies had looked with suspicion on welding grades of aluminum-killed cast steels. An A.F.A. paper (Transactions, A.F.A., 1940) helped dispel that prejudice. More lately, graphitization has concerned some users of cast and wrought steels.

Some consumers asked for specification prescription to eliminate aluminum-killed cast steels. Project 29, A.S.T.M.-A.S.M.E. Joint Research Committee on Effects of Temperature in their 1945 report, and the paper of Smith, Urban and Bolton (presented to the A.S.M.E., December, 1945) may be helpful toward keeping that burdensome requirement out of cast steel specifications.

It is believed that more papers in the A.F.A. dealing with engineering and service characteristics of cast steels would be helpful in properly influencing specification-making bodies. There have been several such within the last three years. The 1932 A.F.A.-A.S.T.M. Symposium was a very useful compilation. Today the Cast Metals Handbook of A.F.A. is designed to keep such information available in regularly revised form.

Light Alloys Specifications

Since the Aluminum and Magnesium Division of A.F.A. has existed as an entity for only a few years, there is little direct history of coordination of its activities with those of specification-making bodies. As illustrative of the relationships of repairs and of departure from chemical specification to mechanical characteristics, which probably will in-

Steel Specifications—Then and Now

In comparing the progress of fifty years in specifications of steel castings, it is interesting to note that the first A.S.T.M. specification published by A.F.A. appeared in 1902 (Transactions, vol. 11, 1902, pp. 33-35, part 2). This specification outlined three classes of steel castings, as follows:

	Hard	*Medium*	*Soft*
Tensile Strength, psi.	85,000	70,000	60,000
Yield Point, psi.	38,250	31,500	27,000
Elongation in 2 in., per cent	15	18	22
Contraction of Area, per cent	20	25	30

In the 1944 A.S.T.M. Standards, 13 separate specifications are given for steel castings, covering 20 classes with 41 various grades, as compared with the 3 classes and 3 grades of the 1902 specifications.

The great advance in the last fifty years has been in the Alloy Steels, unknown a half century ago. Compare the specification given above for 1902 with the latest A.S.T.M. specification for steel castings of the alloy classifications. In the 1944 A.S.T.M. *A148-44 Alloy Steel Castings for Structural Purposes,* there are given three classes and 8 grades are given, with properties ranging in tensile strength as shown below:

A148-44 Specification for Alloy Steel Structural Castings

Class A-2 grades which shall be full annealed.

Class B-2 grades which may be normalized or normalized and tempered and drawn.

Class C-3 grades which may be liquid quenched and tempered and drawn.

		Tensile Strength, psi. (min.)	*Yield Strength, psi. (min.)*	*Elongation in 2 in., per cent*	*Reduction of Area (min.) per cent*
Class A	Grade 1	75,000	40,000	24	35
	Grade 2	85,000	53,000	22	35
Class B	Grade 1	85,000	55,000	22	40
	Grade 2	90,000	60,000	22	45
	Grade 3	100,000	65,000	18	30
Class C	Grade 1	90,000	65,000	20	45
	Grade 2	120,000	100,000	14	35
	Grade 3	150,000	125,000	10	25

fluence specifications, papers of Martin and of Ruppe and Juroff are among several recent ones that might be cited. (TRANSACTIONS, A.F.A., 1942) Consumer representatives on specification-making bodies are influenced only insofar as foundry practices are interpreted in terms of effects on the mechanical and other service characteristics of the castings.

There are four tentative light alloy specifications of the A.S.T.M. today, as follows:

B-26-44-T—Sand Castings-Aluminum Base Alloy (tentative).

B-85-44-T—Die Castings-Aluminum Base Alloy (tentative).

B-80-44-T—Sand Castings-Magnesium Base Alloy (tentative).

B-94-44-T—Die Castings-Magnesium Base Alloy (tentative).

Malleable Specifications

In case of malleable iron castings, both standard A.S.T.M. specifications have been endorsed by the A.F.A. and approved as American Standard by the A.S.A. This clearly indicates coordinated effort, which has been in effect for some years. The two societies (A.S.T.M. and A.F.A.) cooperated in a Joint Symposium in 1931. The A.S.T.M. malleable iron specifications are:

A-47-33—Malleable Iron Castings.

A-197-39—Cupola Malleable Iron.

A-220-44-T—Pearlitic Malleable Iron Castings (tentative).

A-227-44-T—Malleable Iron Flanges, Pipe Fittings and Valve Parts (tentative).

Brass and Bronze Specifications

A.F.A. papers on non-ferrous alloys (other than the light alloys) usually dealt more with foundry methods than with resultant effects on engineering properties. In the A.S.T.M. there was no concrete action on copper base alloy specifications until 1911. Formulation of the specification for 88-10-2 was affected at that time.

This specification was based on older specifications used by other groups and on considerable research data, particularly that by the U. S. Bureau of Standards. While test bar gratings were studied, need for consideration of melting practices led research to be directed into that field.

Unfortunately, the major cause of bronze porosity was diagnosed as "oxidation." Although Woyski and Boeck (TRANSACTIONS, A.I.M.E., 1922) cast some doubt on that diagnosis it was not until the paper of Bolton and Weigand (TRANSACTIONS, A.I.M.E., 1929) that "oxidation" was thoroughly discredited as a major factor in the occurence of porosity.

There is little record of early direct participation by the A.F.A. in test bar, specification, and soundness of bronze investigations, although many A.F.A. members were working on these problems under the auspices of other societies. Among these were Clamer, Wolf, Patch, Romanoff, St. John, Bolton, Binney, Kanter and others. Wolf has been A.F.A. representative on B-5 (Copper Base Alloys) for some years.

Ingot metal suppliers (specifically the Non-ferrous Ingot Metals Institute) have been active in and have financed a number of researches of value.

More Interest Needed

The A.F.A. Brass and Bronze Division has not been unaware of the situation. In relation to other divisions of the foundry industry, it is composed of a number of relatively small producers, making an at best wide variety of alloys. Relatively few men have shown sufficient interest to work intensively on some of the many problems confronting the Division. However, A.S.T.M. specifications were studied carefully and several have been endorsed by the Association.

The CAST METALS HANDBOOK (3rd ed., Non-Ferrous Alloys Section) has an excellent review of A.S.T.M. and other specifications. This is accompanied by what the writer regards as today's most complete and authoritative unit compilation on engineering properties and fields of application. Included are data on copper base, aluminum base, magnesium base, lead base, tin base, zinc base and nickel base alloys. When one considers that the revision committee consisted of three men (St. John, Nass, and Romanoff), the intensive individual effort involved in the undertaking becomes rapidly apparent.

Cooperation of Societies

This somewhat sketchy "history" of the connections of A.F.A. with specifications for metals and alloys may be summarized somewhat as follows:

Although the Association is not in itself a specification-making group for these products, it is vitally concerned in specification and test method development and formulation. It therefore has cooperated both formally and informally in this field.

The American Society for Testing Materials is recognized by the Association and by foundry trade associations as the specification-making body for the foundry industry. In many instances consumer group, federal, and individual specifications parallel or are derived largely from A.S.T.M. specifications. This Society is a logical coordination instrument for both producers and consumers. Efforts are being made to further correlate federal and other consumer group specifications with those promulgated in A.S.T.M., a movement that has the approval of the American Foundrymen's Association because of the many and obvious benefits to its membership that would result.

The Association has promoted numerous developments in castings as worthy engineering materials, and many improved control procedures. Resulting improvements in cast products have been recognized in revised specifications by the A.S.T.M. and other groups. In some cases the meanings of the improvements, in engineering terms, have been made evident in the A.F.A. TRANSACTIONS, and in symposia with the Society. Perhaps even more attention could be vouchsafed to this sound type of product promotion.

Committee Representatives

Considerable as the actual cooperative work has been, still more has been accomplished in less direct and perhaps equally effective ways. We refer to the fact that in A.S.T.M. committees, castings representatives usually are also active A.F.A. workers. These men understand the aims and needs of the Association, and, as "ministers without portfolio," usually are effective in bringing to bear the views of the industry upon subjects of current interest.

Recent organization of the Specifications Study Committtee of the Association should promote increased coherence in the Association's efforts toward influencing specification formulation. The subject is a broad, an intricate and an involved one. Its prosecution demands experience,

study and thorough knowledge of engineering requirements as well as of appropriate foundry methods and controls.

Specifications control the quality of foundry products, which means that they directly influence all foundry methods. Further than that, they set the limitations for castings usage. Therefore the industry is affected in both its manufacturing and in its selling by the work of the specification makers; who must, accordingly, consider such aspects.

"JANE" REININGA

Retires After Long Service In A.F.A.

JENNIE REININGA, Assistant Treasurer of A.F.A. at the National Headquarters Office in Chicago, retired from active service on March 15 after 30 years as a Staff member. Joining the Staff the time C. E. Hoyt first was elected Secretary and Manager of Exhibits, she served successively as stenographer and bookkeeper, and later as Office Manager, and was appointed Assistant Treasurer in 1941.

Actually, Jennie Reininga's affiliation with Association affairs extends back as far as 1911, for she was on the staff of the former Machine Exhibition Co. between that year and 1916. The Machine Exhibition Co. was organized to stage annual exhibits of foundry equipment, under the managership of C. E. Hoyt, and functioned until the American Foundrymen's Association took over the staging of the annual Foundry Shows, in 1916.

When Jane, as she came to be known to many members and to every Board of Directors for the past 30 years, first became an A.F.A. staff member, the National Office consisted of Secretary Hoyt, one stenographer and one bookkeeper (Jane). The membership then stood at less than 1,000, and formation of the first Chapter still was 18 years away. A major activity of the Association was the staging of the annual exhibit (now biennial) of equipment and supplies for foundry use.

Contributed Natural Talents

To the work of handling the myriad office details connected with the staging of national exhibits annually, Jane Reininga brought a remarkable memory for names, a unique capacity for organization, and boundless energy and enthusiasm. Through all the years that followed, she became known for her efficiency and unfailing loyalty to the Association, and was held largely responsible for the smooth running of many phases of 29 annual meetings.

Long responsible for the society's membership work, Jane's ability and willingness to take on more burdens seemed never to have limits. Her sense of business management, had she cared to publicize those talents, would long ago have won her national recognition among organizations of successful business women. At annual meetings of the Association it came to be a sort of tradition that, when a visitor needed information, he was told to "See Jane."

Upon the establishments of A.F.A. chapters in 1934, one of Jane's responsibilities became the servicing of the Secretary and Treasurer of each new local group . . . keeping accounts straight, recording and changing membership records so as to make the work of the chapter officers much easier, checking up on any delinquencies in dues payments, with a constantly and rapidly growing membership. The advent of 33 chapters and 8,000 members, each with his own problems and demands, necessarily doubled and tripled the responsibilities which evolved upon the Assistant Treasurer, and undoubtedly contributed to her decision to retire before completing, as she had long desired, the 50th anniversary year of the Association.

In accepting her resignation, the Executive Committee of the Board, at a meeting held in Chicago, March 12, voted Jane Reininga the thanks of the Association for a job "well done," and invited her to attend the 50th Anniversary Convention and Exhibit, in Cleveland, May 6-10, as a guest of the Association.

At a luncheon given by the Staff in Jane's honor, at the La Salle Hotel, Chicago, March 15, she was presented with a beautiful lapel watch as a token of the esteem of every Staff member. In accepting the gift, Jane declared that "For the next six months I am going to do absolutely nothing . . . and for the first time, really enjoy doing it!"

(ED.—For those of the many foundry friends of Jennie Reininga who may desire to drop her a line of remembrance, her home address is 304 North Grove Ave., Oak Park, Ill.)

When Jennie Reininga, Assistant Treasurer of A.F.A. at Chicago, retired from active service on March 15 after 30 years a Staff member, the entire National Office staff tendered her a testimonial luncheon at the La Salle Hotel. Here Laverne Lahn, who learned the in's and out's of membership work under Jane's teaching, presents Jane with a lapel watch as a token of Staff esteem and remembrance.

REPORT OF A.F.A. COMMITTEE

ALUMINUM ALLOY DIE CASTING

Although the fundamental information on die casting herein presented will be of specific interest to the producer and the consumer of die castings, it should be of general interest to everybody in the foundry industry.

Committee on Die Castings
Aluminum and Magnesium Division, A.F.A.

THE THREE MAIN requirements for the commercial production of die castings are as follows:

1. A properly designed metal die to produce the desired part economically;

2. A machine with a means of injecting metal into the die at the proper speed and pressure and which will hold the die components in alignment under operating conditions; and

3. An alloy which has the proper characteristics for casting and which will give the desired physical properties to the casting.

Die Casting Dies

The design and construction of the die casting die is extremely important to the success of the satisfactory commercial production of die castings. The dies for die casting aluminum are made from alloy steels nominally consisting of 5 per cent chromium, 1 per cent molybdenum, and 0.4 per cent carbon. This steel is heat treated after machining and will be satisfactory for making 50,000 to 500,000 castings or more, depending on the size, shape, etc., of the casting.

Heat Treatment of Dies. The dies are heat treated by placing the blocks comprising the die in a heat treating box with a few pieces of charcoal, or by imbedding the blocks in cast-iron chips. In either case, the box is covered, the joint sealed to exclude air, and the container and contents placed in a muffle furnace where they are heated at a rate of about 100° F. per hour until a temperature of 1200° F. is attained. They are held for two hours at 1200° F. to equalize the temperature of the box and contents before increasing the temperature at the same heating rate to 1600° F., at which temperature they are held for an additional two hours. The temperature is increased at the same heating rate to 1800-1850° F., at which temperature the dies are held for one hour per inch of thickness plus one hour.

The die blocks are removed as quickly as possible from the container and allowed to cool in still air to about 300-500° F., so as to minimize distortion. They are then tempered at 1050° F., for six hours per inch of thickness, removed from the furnace and cooled in air. Hardness should be between 416 and 460 Brinell (444 desired) with a 3000-kg. load. Although little scaling takes place, that which occurs can be removed by descaling process.

It is the practice of some die casting plants to produce a limited number of sample castings from a die before heat treatment, but most plants discourage this practice because, in the running of sample castings, the slides and cores are apt to gall, and the alloy cast may "solder" (alloy) to the soft die walls. Heat checking of the die also is accelerated by this practice.

The die steel can be nitrided after heat treatment to produce a harder surface by treating at 950-1050° F. in a closed container with dried ammonia gas.

The die itself consists of two parts, namely, a cover die and an ejector die, which define the surfaces of the desired part. The addition of an ejector plate and ejector pins behind the ejector die provides a means for removing the casting from the die. Such a die is shown in Figs. 1 to 4.

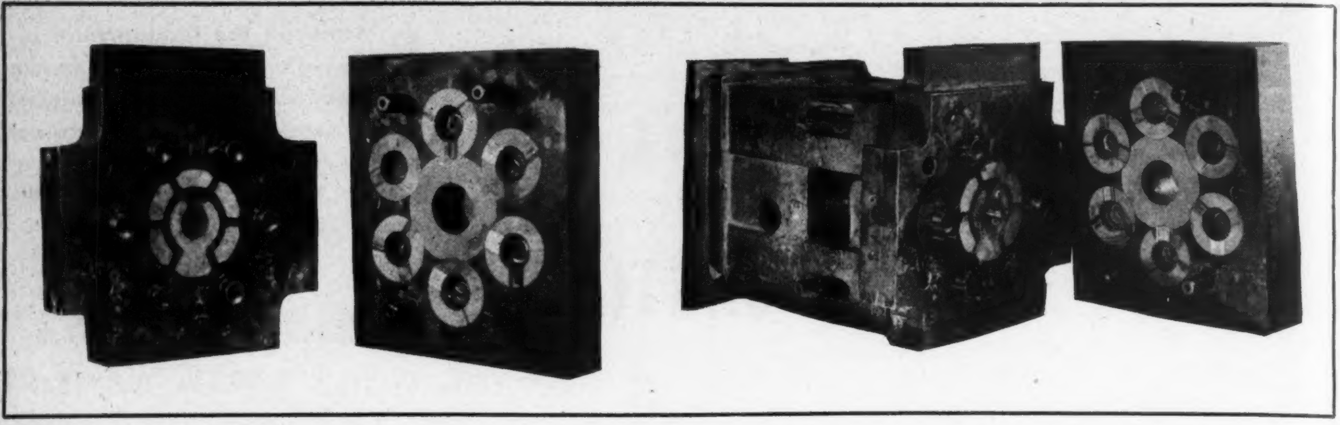
Interior openings are formed in die castings, as in sand castings, by the use of cores, and reduction of machining cost thus is obtainable as might be expected. Since any but parallel cores would interfere with the removal of the casting from the die, cores must be provided with means for removal from the casting before they interfere with either the opening of the machine or the ejection of the casting.

Casting Ejection Mechanism

A die casting is designed to stick to the ejector die and is removed with the aid of pins (called ejector pins) which are held by the ejector plate. The plate can be moved by a rack and pinion, which can be operated manually, hydraulically, or by means of a linkage to a part of the casting machine. Direct connection to hydraulic cylinders also is used, as are various cam arrangements.

Ejection can also be accomplished by means of a bar on the casting machine, which stops the ejector plate as the die opens and so receives its name "bump ejection." A more recent method involves the use of tapered blocks in which die cavities are cut. When these tapered blocks are moved for-

This paper will be presented and discussed at an Aluminum and Magnesium Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6-10, 1946. Oral and written discussion is solicited.



ward by ejectors, they carry the casting with them and open up in proportion to the taper. By this method some external undercuts can be cast direct, and the undercut will clear the die as it opens so that the casting can be removed.

The ejector plate usually contains several large pins, ground so as to be flush with the face of the die when the ejector pins are in the casting position. When the die is closed, these so-called "surface pins" enable the ejector pins to retract without being bent or broken by contact with the cover die, and remain always in position to eject.

Special properties which are not characteristic of the cast alloy frequently are required at certain points in a casting. Under such requirements the die and the part to be die cast are designed so that previously fabricated parts (termed inserts) having the desired properties are anchored in the casting by the cast metal (Fig. 5). Inserts provide greater wear resistance, strength, hardness, conductivity, bearing, magnetic and spring properties, and simplify design by joining several castings into a unit when coring and undercuts make such devices necessary.

These inserts are usually keyed, knurled, or undercut in such a way that they will not turn or pull out of the casting, but can be designed so that some relative motion between the insert and the casting will take place. They may be metallic or non-metallic, iron, steel, brass, bronze, graphited bronze (oilless bearing), phenolic and other type resins, and even wooden inserts have been used. Inserts may be produced as screw machine products, stampings, forgings, etc.

Dies designed for one impression only are called single dies; if for more than one impression of the same part, they are called multiple dies, which may yield, in some cases, as many as forty impressions. Dies can give impressions of different parts, so that all the castings required for one assembly may be made in one shot. Such dies are called combination dies, which can be made so that some of the impression blocks can be replaced by others. The latter are referred to as interchangeable dies.

Holding dies, made by machining cavities in the large die blocks into which standard small dies for various parts can be inserted, are a variation of the interchangeable die and are known as unit dies. Holding dies will hold six unit dies at one time, and each of which, depending on the size of the casting to be made, may yield impressions for several parts.

The unit die method has made it possible to produce small parts economically by dividing among six dies the labor required to make each shot. Obviously, the same alloy should be specified for the parts to be run simultaneously. Where dimensions must be held to the lowest possible tolerances, single dies must be used.

Die Casting Machines

The die casting machine can be considered as consisting of two major parts, namely, one to hold the die, and the other to hold and/or inject metal into the die cavity. Basically, the die supporting part of the machine is the same, regardless of the method used for metal injection. It consists of a rigid frame and a means for closing the die, locking it under pressure, and later opening it to allow the casting to be removed. The schematic drawing of a die casting machine shown in Fig. 6 is self-explanatory.

Fig. 1 (left)—Cover and ejector die blocks. Fig. 2 (right)—Ejector die block mounted on die base with ejector pin plate assembled and cover die block.

Machine Frame. The frame of the machine must be rigid enough to support without deflection the weight of dies which may be placed on it. It must be adequately massive so that the pressure exerted on the injected metal does not stretch the structural bars and allow the die to open during the "shot." This condition would not only make it difficult to maintain the dimensions of the casting across the die opening, also, because of the loss of pressure on the metal, would lead to decreased density of the casting. The liquid metal which would be sprayed from the die in such a case would be dangerous not only to the operator of the machine but to others in the vicinity.

Although machines may be operated both vertically and horizontally, most modern machines are built for operation in a horizontal position. This feature makes it easier to change dies.

Die Actuating Mechanism. The devices for opening and closing the die are usually hydraulic cylinders directly acting on the movable plate, or in combination with a mechanical linkage or toggle. The pressures required to hold the die together are 600 tons in many cases, and probably sometimes more.

There are two methods of injecting metal in general use. They are the "gooseneck" method and the "cold chamber" method.

"Gooseneck" Method. The older

or "gooseneck" method involves metal injection by the application of air directly on the surface of the liquid metal in a container called a "gooseneck." The "gooseneck" is supported in the molten bath and is refilled after each shot by dipping the nozzle under the surface of the bath.

The steps in the casting cycle using the gooseneck machines are as follows:

1. Close the die, then raise the gooseneck from the "at rest" position in the bath to the "casting" position, with the gooseneck nozzle held firmly in the bushing at the pouring gate.

2. Make shot by applying air pressure on the top of the metal in the gooseneck, forcing liquid metal through the gate into the cavity.

3. Maintain this pressure until the casting has solidified.

4. Lower the gooseneck to starting position.

5. Open the die and eject the casting by moving the ejector pins forward.

The process is repeated after retracting the ejector pins. A simple sketch of the "gooseneck" is shown in Figs. 7 and 8.

Objections to Gooseneck Machines. This type of die casting machine has several objections which have resulted in constantly diminishing use. Since the gooseneck and metal pot are made from cast iron and the gooseneck moves up and down in the bath at each shot, the molten aluminum alloy dissolves iron from these parts and it becomes almost impossible to control the iron content in the casting. The iron content by specification is usually allowed to rise to 2 per cent in castings made by this process, which does not give the best properties to the metal.

It has not proved practical to use air pressures over 500 to 700 psi. in this process, and the castings are not as dense as those made by the newer "cold chamber" process with its higher pressures.

The gooseneck machine is also more dangerous to operate than the cold chamber machine, because the metal may squirt out between the nozzle and the die. The metal, as it enters the pouring gate, is sprayed into the cavity and these oxide-covered sprayed particles trap air from the gooseneck, nozzle, gate and the die cavity in the casting.

"Cold Chamber" Method. The "cold chamber" method is now the process in most general use. In this method, a piston operated by a hydraulic cylinder applies pressure on the metal in a chamber which is charged by hand ladling. This mechanism is used both vertically and horizontally, although most machines use the horizontal type.

The steps in the cold chamber casting cycle are as follows:

1. Close the die.

2. A ladle of the proper size, which will furnish just enough metal to fill the cavity, gates and overflows, and leave a plug in the chamber about ¾ in. to 1 in. thick is used to ladle metal from the holding pot to the chamber.

3. The piston is moved forward by the hydraulic cylinder, with the speed controlled by a valve set to fit the conditions, and forces the metal in the chamber through the gate into the die.

4. When the metal has solidified, the die is opened, and since the pressure is still being exerted by the hydraulic cylinder, the plunger pushes out the slug remaining in the chamber and is then withdrawn to its starting point. Cores are withdrawn and the casting ejected.

Objections to Cold Chamber

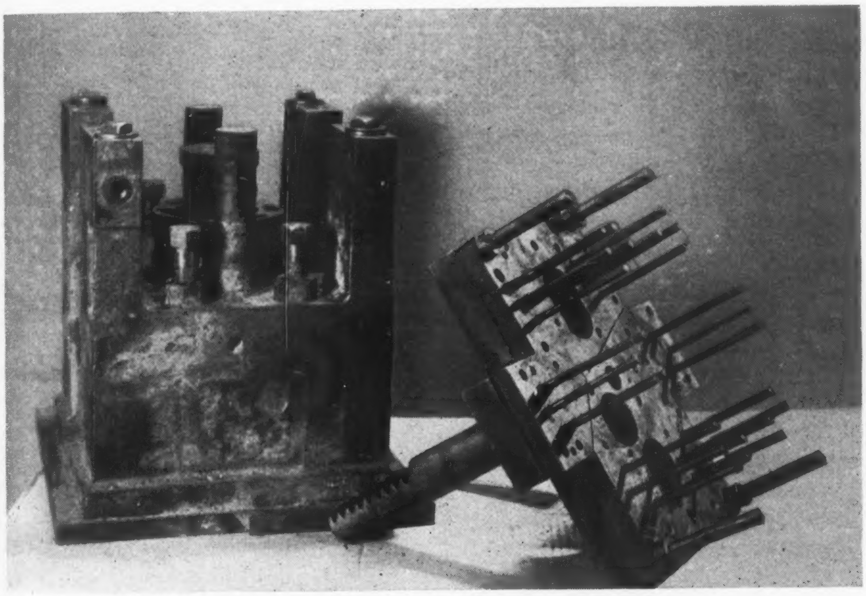


Fig. 3—Die base (left) and ejector pin plate assembly.

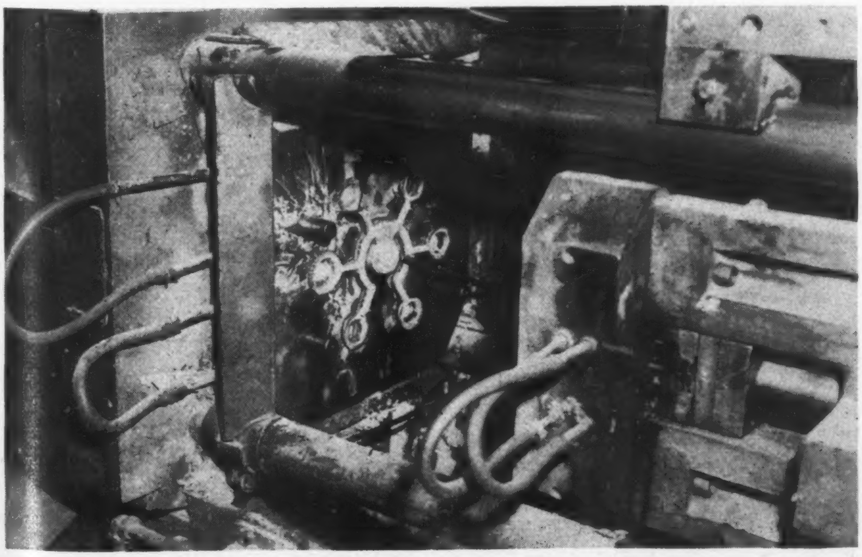


Fig. 4—Die mounted on machine.

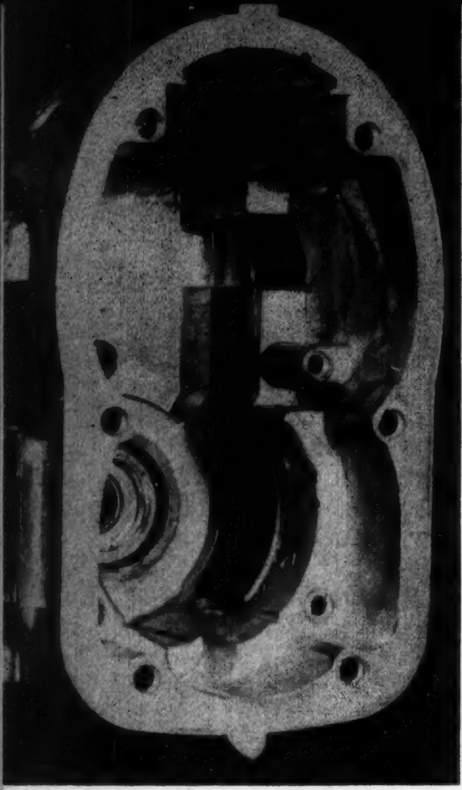


Fig. 5 — Electrical motor housing showing inserts.

Machines. The objection to the horizontal cold chamber is that the shot sleeve is only partially filled with metal, which starts to solidify along the walls of the sleeve as soon as it is poured. The advancing plunger gathers up liquid and solidified metal, and the air above it, and forces them all into the die. Practical considerations, such as speed of operation, have caused the horizontal chamber to be favored over the vertical. The vertical sleeve does not have the objections just cited, but the plunger tends to stick and the process is slower.

Advantages of Cold Chamber Method. Since the hot metal is in contact with the walls of this cylinder for only a short time and is ladled out of a pot which can be coated or enameled to prevent iron pick up, the iron content of the casting alloy can be controlled to a much lower figure than in the gooseneck machine. Iron contamination can, if necessary, be kept at 0.8 per cent or below. Castings made from alloy of low iron content solder to the die in many cases, and for this reason most specifications allow 1.3 per cent Fe, which causes only a slight reduction in physical properties of the finished casting produced.

Injection plunger speeds may vary from 250 in. per sec. to 5 in. per sec. At the higher figure, the metal is sprayed into the die, while at lower speeds the metal feed changes to a flowing stream. Larger pouring gates are required for slow plunger speeds. The slower speeds can be used only for heavy-walled castings.

Volume of Metal

In other words, the volume of metal entering the die per unit of time, determined by the gate cross-section and the pressure on the metal, is the deciding factor. However, it frequently is impossible in thin-walled castings to use a gate sufficiently large to fill the cavity properly at low speeds if the gate must feed into too thin a section.

The pressures involved in this method vary from 2500 psi. on the metal to as high as 100,000 psi., although most work is done somewhat below 20,000. Denser and stronger castings can be produced by the cold chamber method than can be produced on the gooseneck machine.

A die casting alloy should have a short freezing range to minimize cracking of the casting in the die during solidification. It should have a composition low in contaminating residual impurities, and of course should be gas free and dross free. In order to achieve these purposes, it is necessary to start with metal of the desired purity, and then control the process so that the metal in the finished product is essentially unchanged.

Most die casting concerns now purchase their metal already alloyed. However, all incoming metal should be carefully analyzed to make certain that it meets the specifications under which it was purchased.

Whenever the hourly requirements for molten alloy are high— for example, 1000 lb. per hr., melting can best be accomplished in refractory-lined reverberatory type furnaces. Although they usually are fired by gas or oil, in special cases coal has been used as a fuel. No iron is picked up by the molten metal. The large surface of this type furnace aids in securing contact between the molten metal and the flux, and makes drossing more complete. The movement of the metal through the furnace is slow, so that any high iron or manganese compounds present will be deposited as a sludge in the bottom of the furnace and later drawn off.

The metal drawn out of the reverberatory usually is delivered in pre-heated bull ladles directly to the pots at the casting machines. If molten metal is delivered in this fashion, the temperature control of the metal in the pots can be maintained within closer limits than if ingots or solid scrap are added directly to the pots.

If the demands of the casting room are too low to justify the use of a reverberatory furnace, other methods of melting can be substituted. These range from horizontal cylindrical furnaces holding perhaps 1500 lb., through tilting furnaces holding 500 lb., to melting furnaces placed at each machine, where the metal is melted and ladled into the holding pot at the machine as required.

Metal Temperature Control

Both the melting furnace and the holding furnace should be temperature controlled to avoid overheating of the metal and to maintain the temperature found by experiment to produce the best castings. Automatic control has been found superior to manual control of temperatures.

The holding furnaces usually are gas-fired, designed to allow holding 250 to 300 lb. of molten aluminum at the machine. Either cast iron pots (which can be coated with enamel or other materials to reduce the iron pick-up) or refractory pots are employed, the latter being more brittle than the cast iron but not soluble in the aluminum alloy.

In the die casting industry, gates and sprues represent a considerable percentage of the weight of an untrimmed casting. Such scrap, plus reject castings, represents 50 to 75 per cent of the metal melted.

Reverberatories are operated by charging as much metal into the melting chamber as will sink into the bath and by repeating this process as soon as a charge has melted, until the furnace is full. Usually a ratio of two or three parts of gates and other scrap is melted with one part of ingots in each charge.

A sample for analysis is taken and is analyzed by spectrograph, a complete analysis of a heat being made in 20 to 30 minutes. During this period, if much dross is on the surface, it is fluxed with mixtures of

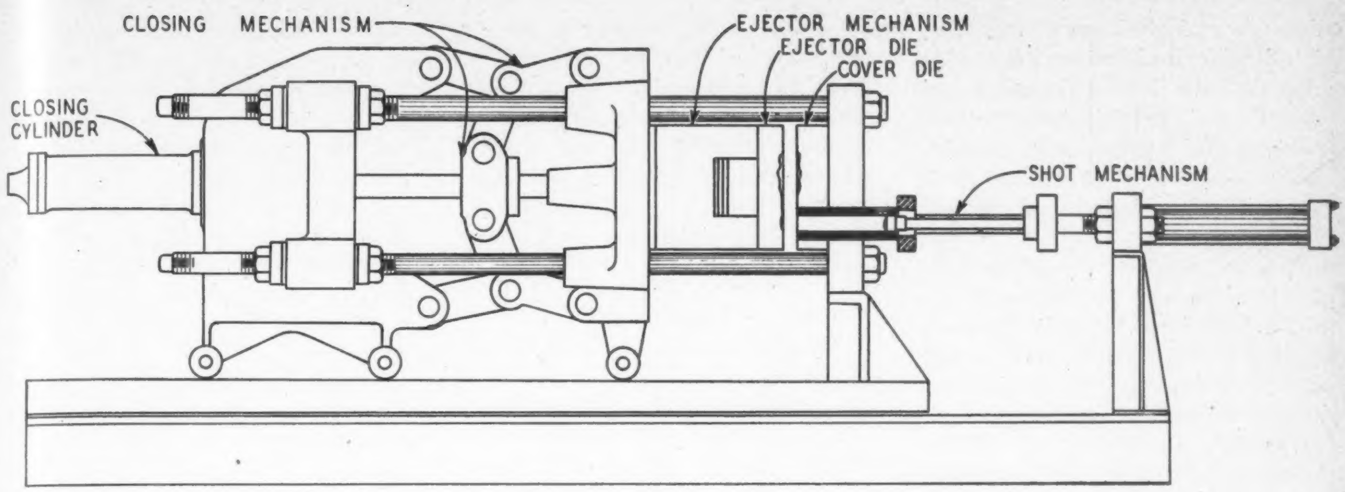


Fig. 6—Schematic drawing of die casting machine.

salts such as sodium fluoride, potassium fluoride, sodium chloride, etc., which can be mixed in the plant or purchased as a proprietary flux. The dross should be cooled as quickly as possible to prevent oxidization of the contained aluminum, which usually is sold to a secondary aluminum dealer for recovery.

Metal Analysis Control

When the analysis has been received, metal composition is corrected and the metal taken by bull ladles to fill holding pots as needed. As much as 4000 lb. can be taken from a reverberatory holding 7000 to 8000 lb. before recharging. In the meantime, if metal demand is great, other reverberatories are run in overlapping cycles.

A reverberatory can be continuously charged at one end and discharged at the other, but control of the metal analysis is less exact with the batch method of melting.

Inasmuch as most foundries use more than one alloy, it is desirable to analyze the holding pots regularly to avoid mixing of alloys. The high magnesium type alloys usually are melted in small melting furnaces, as are alloys of high purity where the quantities desired are low. It is also desirable to flux or skim the holding pots several times a day to remove the dross, which may cause machining difficulties in castings.

Aluminum Base Alloy Properties. The outstanding characteristics of aluminum die castings are:

1. Low specific gravity.
2. Corrosion resistance.
3. Retention of luster for longer periods of time after polishing.
4. Freedom from dimensional changes.
5. Retention of properties at subnormal temperatures.
6. High thermal and electrical conductivity.

This combination of properties has resulted in wide use of aluminum die castings. The average specific gravity of aluminum die castings is 2.80, as compared with 1.80 for magnesium base alloys. For many applications, especially small parts, this weight differential is negligible.

The ability of a part to take and hold a polished luster is most important, and advantage is taken of this property in the finishing of many die castings.

Aluminum die castings have excellent corrosion resistance in the as-cast state. When it is desired to increase resistance to attack by corrosive media, the anodizing treatment may be resorted to, since it greatly enhances corrosive resistance.

Aluminum is one material capable of withstanding extremely low temperatures without affecting original ductility. For this reason, aluminum die castings have found extensive use in aircraft refrigeration and similar applications where temperatures of —60° F. or lower are encountered.

Many aluminum alloys have been used for die castings, but most die casters now use three main types, as shown in Table 1.

Silicon-Aluminum Type Alloys. Alcoa alloy 360 is a high strength alloy which probably will replace Alcoa 13 (ASTM S9). The former does not show the segregations of primary silicon in the center of heavy sections when cast on certain type casting machines. These segregations, known as eutectic chill flakes, are frequently found in castings of the 12 per cent silicon alloy. Either of these alloys is used when a fluid alloy is required to fill complicated and thin-walled shapes, where good corrosion resistance is required.

Difficult to Cast

A special grade of the 12 per cent silicon alloy (Alcoa 13x), containing a maximum of 0.8 per cent iron, is somewhat more difficult to cast than the standard Alcoa 13 (ASTM S9), but produces castings with higher ductility, shock resistance and corrosion resistance.

Copper-Silicon Type Alloy. This alloy is an outgrowth of World War II. It is based on the use of aircraft scrap, most of which has a 4 per cent copper content. By eliminating most of the magnesium in the scrap and adding up to 9.5 per cent silicon, an aluminum alloy is obtained which has been found quite satisfactory as a die casting alloy. It possesses good casting characteristics and has excellent physical properties.

This alloy was used almost exclusively for aluminum ammunition, component castings and other uses, to such an extent that it can be considered a general purpose aluminum die-casting alloy. In the author's opinion, this alloy may become the general die casting alloy for post-war use, because of low cost.

Magnesium-Aluminum Type Alloy. The ASTM G2 alloy is the best

alloy where high impact resistance, high ductility and optimum corrosion resistance are desired. It takes and retains a beautiful luster when polished, and has optimum machinability properties. However, it is more difficult to cast than the silicon type.

Special properties undoubtedly can be obtained by casting other alloys than those listed in Table 1. However, in an effort to prevent contamination, every foundry endeavors to standardize on those alloys which, in the main, will be satisfactory for most of the castings required. Any castable alloy can be die cast by setting up separate melting pots, etc., but this should be avoided whenever possible.

Some special die castings have been produced which can be both solution treated and precipitation hardened, although die castings as a class cannot be given a solution heat treatment because they will blister. However, a low-temperature aging will result in enhanced properties if the alloy is normally improved by complete heat treatment.

Since die castings are made in steel dies, it is obvious that the shape of the casting must be such that it can be withdrawn readily from the die. This is accomplished by constructing the die without undercuts (except as noted below), and with proper tapers on all surfaces.

Tapers. All external surfaces should be designed with a continuous taper, maximum at the parting line of the die. It should be as large as possible, with a minimum allowable taper of 0.010 in. per in., except for small depths where, if required, straight sides can be cast. The minimum taper that should be designed for cores is 0.015 in. per in., and the largest dimension must be at the base of the core. The reason for the larger draft allowance on internal surfaces is readily understood when the large thermal contraction of aluminum and its alloys is considered.

Undercuts. Internal undercuts can be cast only by the use of collapsible cores. Such undercuts slow the casting cycle, cannot be controlled as accurately as can sections of solid steel, and add to die cost.

External undercuts are produced by loose pieces in the die, which are ejected with the casting and must be removed and replaced in the die for another shot by the use of slides, or by "angular ejection." The use of these methods may lead to excessive "flash" on the casting which must be removed, and may result in reduction of dimension accuracy, higher die cost, and slower speed of production.

Redesigning

Therefore, before planning to cast undercuts, it is always wise to consider redesigning the part so that it will accomplish its purpose as a simpler casting. However, in many cases, undercuts should be used and will show savings.

Cores. Cores should be designed to provide the highest possible ratio of diameter or thickness to length. Long, thin cores should be avoided, as they have a tendency to burn out and bend or break, thus increasing die maintenance. Through cores, with both ends supported, should be used for small holes wherever possible. Interlocking cores may increase die maintenance costs through breakage.

Parts should not be designed with openings completely through the casting, unless required. The flash that will appear around the opening at the far end will require an extra cleaning operation. Where possible, cores should be used to maintain uniform section thickness and for reduction of weight. They should also be used wherever openings are to be drilled or tapped, since the density of metal is greater in heavy sections around cores than in uncored heavy bosses, where shrinkage voids tend to appear.

Cores can be used to produce openings of shapes that would be difficult if not impossible to machine. Very small openings are not cored, since the cores would require frequent replacement, and such openings usually can be drilled more economically. No opening less than 3/32 in. diameter should be cast, and the length of the core should not exceed four times the diameter. Cores of ½ in-1 in. diameter may have an unsupported length of six to eight times the diameter of the opening.

Bosses. Bosses are frequently provided on die castings and should be cored to provide metal of sufficient density for tapping. Outside threads should not be used on bosses, but where outside threads are required,

Table 1

Composition and Physical Properties of Aluminum Die Casting Alloys

	Alloy Type			
	Silicon-Aluminum		*Copper-Silicon-Aluminum*	*Magnesium-Aluminum*
Designation				
ASTM	S9	—	SC6	G2
Alcoa	13	360	A380	218
Composition (per cent)[1]				
Copper	0.6	0.6	3.0–4.0	0.2
Silicon	11.0–13.0	9.0–10.0	7.5–9.5	0.3
Iron	1.3	1.3	1.3	1.8
Magnesium	0.1	0.4–0.6	0.1	7.5–8.5
Manganese	0.3	0.3	0.5	0.3
Zinc	0.5	0.5	0.6	0.1
Nickel	0.5	0.5	0.5	0.1
Tin	0.1	0.1	0.3	0.1
Total other impurities	0.2	0.2	0.5	0.2
Properties[2]				
Tensile strength, psi	40,000	42,000	41,000	42,000
Yield strength, psi. (0.2 per cent set)	18,000	23,000	23,000	23,000
Elongation, per cent in 2-in.	2.0	2.0–4.0	3.0	5.0
Charpy impact, ft. lb.[3]	2.0	2.0–5.0	3.5	10.0
Specific gravity	2.66	2.68	2.76	2.53
Weight lb./cu. in.	0.096	0.097	0.099	0.091
Melting point, °F	1065	1110	1090	1160

[1] All percentages are maximum unless a range is shown.
[2] Typical physical properties on die cast aluminum test bars. These properties do not exactly represent the properties of castings but are used as a guide for engineers in design.
[3] Impact determined on ¼-in. x ¼-in. bars.

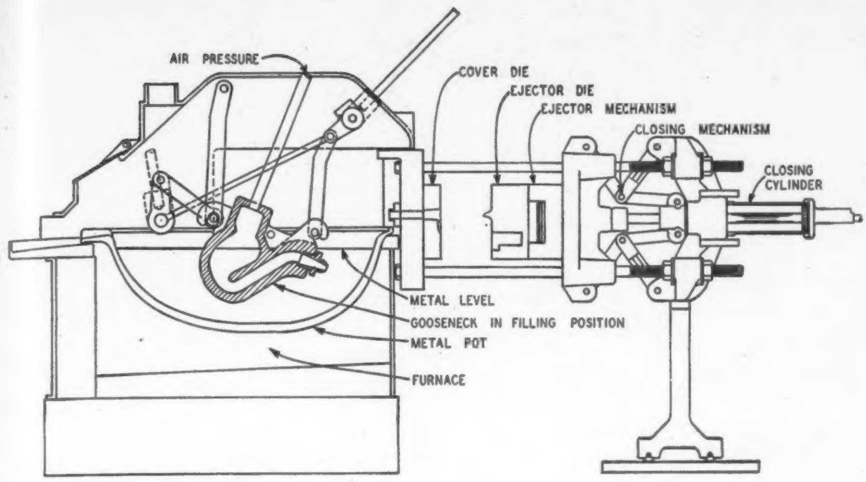


Fig. 7—Aluminum gooseneck machine in open position.

an insert of some other material should be used. Speed nuts should be employed if possible.

Section Thickness. A casting must have a minimum thickness of 0.060 in. to cast well in small areas, and as much as 0.090 in. or more on long, flat sections. The usual requirement is that the thickness be one-thousandth of the area cast. Section thickness should be as uniform as possible, and where changes in section occur they should be made as gradual as possible by means of fillets. Fillets should be used at all changes of section and should be as large as practicable.

Too great a section thickness should be avoided because, the thicker the section, the greater the tendency toward porosity. Contrariwise, the thinner the section, within the limits of casting practice, the less the porosity.

In order to avoid heavy sections, ribs are used to provide greater strength and stiffness than would be afforded by a flat, thin section. Shadow marks on the flat side over a rib may be avoided if the thickness of the section is great enough, perhaps 0.100 in. or if the rib width is kept below 70-80 per cent of the section thickness.

Threads. Threads are not ordinarily cast on aluminum die castings. However, external threads have been cast by the angular ejection method on millions of shell parts during the war—with a coarse pitch of about 12 threads per inch. Internal threads usually are made by drilling and tapping a cored hole. Cut external threads are not used in aluminum since they are stress raisers and therefore not desirable.

Tolerances. The basic advantage of die castings over other aluminum castings is that a die casting is cast to the finished size in most cases, with little machining required in other cases. The surface is smooth, and openings of any shape can be cast to precise dimensions and to exact spacing.

The dimensional variation between castings from the same die is low. For example, tolerances on those parts of a casting made in the solid die (exclusive of dimensions across the parting line, or across lines where slides join the die) are only 0.0015 in. per in., with a minimum tolerance of 0.003 in., although the required tolerance across the parting line is greater.

Where machining to close tolerances is necessary, a stabilizing treatment may be given the castings. This consists in heating the castings to 450° F., and holding at this temperature for two to five hours. The casting and solidification strains are relieved, and practically no further change in dimensions will be experienced.

Since a die casting is made from rapidly chilled metal, the grain size is small and physical properties of test bars as die cast are higher than test bars from the same alloy as-cast in sand or gravity permanent molds.

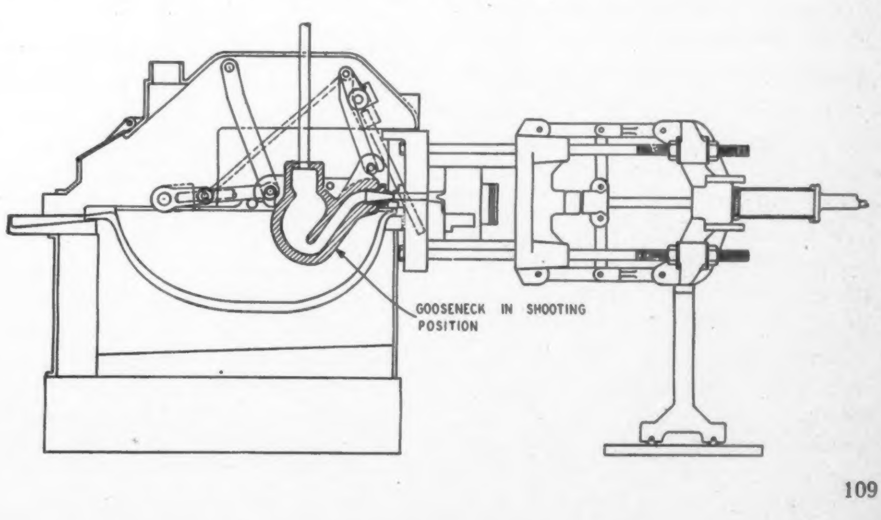
Size of Die Castings. At present, aluminum die castings do not usually exceed 15 lb. in weight, although there is no practical reason why castings considerably larger could not be made if required. However, the dies would be much more expensive, and larger machines might be required than those now in general use.

Trimming Die Castings

When a die casting comes from the machine, it consists of the casting or group of castings connected by gates to the sprue and surrounded by overflows, flash and ejector pin pads. These must be removed before the casting is used. Unless the gate is very heavy, or the casting quite fragile, the gate is broken off before removing other excess metal. When the gate cannot be broken off, it is either sawed or cut off in a chopper.

Whenever possible, the balance of the group is placed in a trimming press, operated either by foot or mechanically, and all excess metal around the parting line is removed simultaneously. Sometimes it is necessary to separate the castings

Fig. 8—Aluminum gooseneck machine in closing position ready to make shot.



made at one time and to trim them individually. Hand filing is avoided, except in cases where trimming either cannot be done or can be done only incompletely. Small lots are usually hand filed. Some surfaces require grinding on disc grinders or sanding belts.

Inspection

Before using aluminum die castings, and in the process of casting, various means of inspection are employed, depending on the end use of the part. The only way of non-destructively checking the internal condition of the casting is by means of x-ray, either on film or by fluoroscopic screen.

Process Inspection. Die casting producers utilize their radiographic equipment during the initial stages of production in order to correct gating, venting, overflows, etc., until the die is producing acceptable quality castings. By means of regular checking, quality is maintained. The castings may also be subjected to percentage checks up to 100 per cent, if the application requires it.

Fluoroscopic inspection is less expensive than film radiography, but is less sensitive, in the author's opinion, since it is only capable of detecting defects three to five times as large as can be detected by film radiography. In all cases, the end use of the casting determines the extent of inspection required.

End Use Tests. Castings are designed for use where definite mechanical properties are required. Tests subjecting castings to loads equal to, or greater than, service requirements are applied, insuring satisfactory performance.

Castings frequently are required for pressure applications. In such cases, they are pressure tested by applying gas or hydraulic pressure on specific sections.

Aluminum Die Casting Applications

The applications of aluminum die castings extend to practically all industries. A few examples of their use by industry follow:

Household Utilities. Vacuum sweepers, washing machines, ironers, refrigerators, food mixing devices, cooking utensils, waffle molds.

Electrical Industry. Motor housings, motor end shields, generator housings, instrument cases and frames, telephone, radio, radar and television parts, phonograph parts and record changers.

Optical Industry. Cameras, projectors, binoculars, microscopes.

Aircraft. Various starter motor parts, conduit boxes, airscoop, carburetors, hardware.

Business Machines. Typewriters, adding and tabulating machines, stenotype cases.

Automotive Industry. Trim, carburetors, generator parts, brake shoes and hydraulic brake parts.

Marine Industry.

Portable Tools.

Die Cast Surfaces

Surface as Cast. A die casting has a very smooth surface as cast, but a large flat area is difficult to polish to a brilliant luster, hence the area usually is designed with a raised surface. A depressed design on the surface results in high die

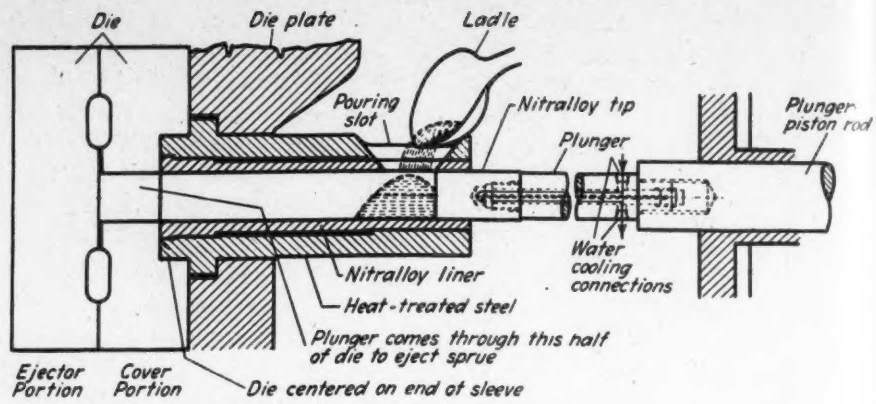


Fig. 9—Sectional diagram showing the die, cold chamber, and horizontal ram or plunger (in charging position) of a modern cold chamber type of die casting machine.

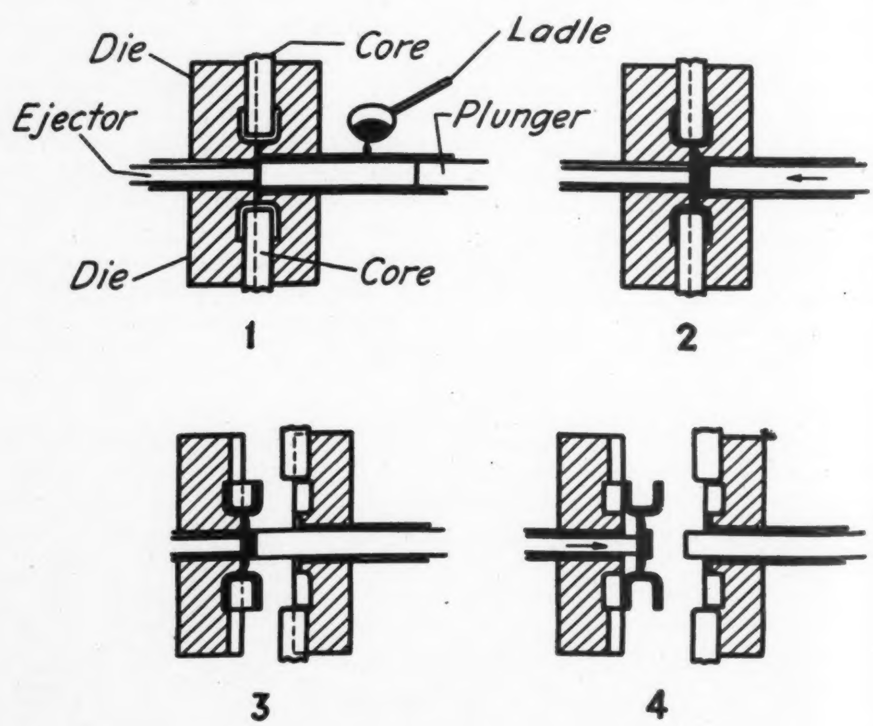


Fig. 10—Diagram illustrating four stages in the production of cup shaped die castings in a cold chamber machine having a horizontal plunger: 1—Ladling metal into cold chamber. 2—Molten metal after it is forced into die. 3—Cores withdrawn, die opened and plunger advanced to eject casting from fixed half of die. 4—Plunger withdrawn and ejector advanced to force gate of casting from ejector half of die.

costs, since it requires cutting away the die surface so as to leave the raised design.

Where a number or design is required below the surface, it usually is obtained by placing the design on a standing pad, thus forming raised letters on the casting below or flush with the surrounding surface.

Ejector pin marks are undesirable therefore are frequently placed on pads which, attached to the casting, can be broken off in the trimming process.

As-Cast Surface Standards

No standards are available for surface finish in the die casting industry. However, the notes below may prove helpful:

Decorative Finish. This finish represents the ultimate in casting surface finish and can be attained with a 220-grit grease wheel at the parting line only, followed by buffing of the entire part. Parting line must be evenly matched and solid; shrinkage areas at parting line are *not* acceptable. Solder and waves are *not* acceptable.

Service Decorative Finish. This finish is required on parts from which service as well as ornamentation are expected. In addition to the 220-grit grease wheel at the parting line, spot polishing with the same wheel is anticipated. Slight solder, waves and small surface run marks are allowed. Parting line must be evenly matched, and shrinkage spots at parting line held to a minimum. Slight porosity at gate is acceptable.

Commercial Die Cast Finish. Polishing of parting lines and spot polishing to start with a 180-grit grease wheel. Light solder, waves, run marks and shallow surface porosity are acceptable. Slight porosity at gate and parting line, and slight shrinks at parting line, are acceptable for this grade.

Mechanical Finish. A finish specified where solidity and strength are the prime requisites. Porosity *cannot* be accepted, but slight shrink spots and waves may be acceptable. Parting lines should clean up in die trimming or should be filed.

Paint Finish. Finish specified where a ground coat is applied before the finish coat. Surface imperfections such as run marks, cold shuts, slight surface porosity and small shrink spots along the parting line are acceptable. The parting line should clean up when ground with No. 150 emery.

Finishes for Die Castings

Aluminum die castings are covered with an oxide film which constitutes an important advantage from a service standpoint. For numerous applications, the ability of aluminum alloys to form and maintain this natural film is sufficient protection, and further finishing is not necessary.

For many other applications, however, where a more decorative appearance or better resistance to service conditions may be desirable, a wide assortment of durable and attractive finishes is available. These finishes are classified as follows:

Mechanical Finishes, developed by abrading or working the die-cast surface by mechanical means to obtain a polished or textured effect.

Chemical Finishes, produced by treating the castings with chemical solutions to give etched surfaces or oxide coatings having various properties for specific application.

Anodic Finishes, formed by anodically oxidizing the castings in a suitable electrolyte to form a substantial oxide coating, which may then be given supplementary treatments to seal or color it.

Electroplated Finishes, applied by the electro-deposition of metals, such as nickel or chromium, on the aluminum surface.

Paint and Organic Finishes, which are clear and pigmented coatings applied by spraying, brushing or dipping.

The methods used or combined, in a commercial finishing procedure for any die casting, will depend upon sales and service requirements, cost considerations, design of casting (size and shape) and alloy type. Where no background of experience exists, it is advisable for the user of aluminum die castings to consult with the die caster or an experienced jobbing finisher.

TEN PAPERS WERE
Presented At 1896 A.F.A. Meeting

ELSEWHERE IN this issue will be found the complete Program for the 50th Anniversary Convention May 6-10, including scores of valuable papers dealing with practically every phase of castings, metallurgy and practice.

As a matter of comparison, it is interesting to look back upon the first A.F.A. Convention in 1896 and to see what comprised the technical program of that first meeting. The *Journal of American Foundrymen's Association* for 1896 lists 10 papers that were presented and discussed, as follows:

"Chemistry of Iron, with Determinations and Their Value," by Charles James, M.E. of H. Disston & Sons, Philadelphia; and W. C. Henderson, Thomas Devlin & Co., Philadelphia.

"The Strength of Cast Iron, with Samples," by W. J. Keep, Detroit.

"Apprenticeships, Their Value and How to Make New Molders," by D. J. Matlack, of I. P. Morris Co.

"Foundry Cranes, the Different Power Used to Drive Them," by A. E. Outerbridge, Jr., Wm. Sellers & Co., Inc., Philadelphia.

"The Air Compressor for Use in the Foundry," by C. W. Shields, Ingersoll, Sergeant Drill Co., Easton, Pa.

"Cupolas and Cupola Practice Up to Date," by Dr. Edw. Kirk, Philadelphia.

"Utility and Advancement of Green, Dry and Loam Sand Moulding," by Thomas D. West, Sharpsville, Pa.

"Gear Molding and Gear Molding Machines," by S. Groves Taylor, Wilson & Co., Pittsburgh, Pa.

"The Sand Blast for Cleaning Castings," by Fred C. Brooksbank, Ward & Nash, Boston.

"Molding Machines and Their Appreciation," by Harris Tabor. Tabor Mfg. Co., Elizabeth, N. J.

During the half century since that first small organizational meeting, the A.F.A. TRANSACTIONS recording papers presented at the past 49 Annual Meetings constitutes perhaps the most complete library of foundry practice to be found anywhere in the world today.

MALLEABLE IRON FOUNDRY

CORE PRACTICE

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Production of cores for any foundry, and for malleable foundries in particular, is of great importance. The quality and characteristics of dry sand cores definitely influence the quality of the castings produced.

The purpose of this article is to outline briefly the production of dry sand cores in a malleable foundry manufacturing agricultural castings and chain links. Castings produced regularly in this foundry vary in weight from approximately one oz. to 25 lb., with an average weight per casting of about ¾-lb.

Raw Materials

Practically all cores in this foundry are made from one of four different sands, or a combination of two of these sands. The sand most commonly used is a locally obtained bank sand containing a small amount of clay. The relatively low cost of this particular sand is one of its chief advantages. The other three sands commonly used are washed and dried Ottawa silica sands. The physical characteristics of these four sands are given in Table 1.

Core oil used in this plant is a petroleum polymer type oil having the following chemical specifications:

Saponification No.	80-85
Iodine No.	195 (min.)
Acid No.	14-17
Specific Gravity	0.940

This core oil has been found quite satisfactory for most work when all of its characteristics are considered. However, a faster baking oil having similar chemical specifications is used for some applications.

Commonly known, commercially prepared cereal binders are used to obtain green strength in most of the core sand mixtures. In a few instances an Albany type molding sand is added in small amounts to produce definite properties. Due to the excessive absorption of oil by the clay in molding sand, this practice is not advisable unless necessary.

Mixing is done in a muller-type mixer. The usual amount of sand mixed is 34 gal. per batch. The dry ingredients, sand and cereal binders, are mixed together for approximately one min. before the oil and water are added. The total mixing time varies with the different mixes (from 4 to 6 min.) and is measured with an interval timer. The moisture content of each batch of sand is carefully determined with a moisture tester. Definite moisture ranges have been set for each mix, and it

Table 1
Sieve Analyses of Sands Used

	Retained, per cent			
U. S. Bureau Standards Sieve No.	*Colona Bank Sand*	*Ottawa Sand "A"*	*Ottawa Sand "B"*	*Ottawa Sand "C"*
6	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0
40	0.7	0.3	0.5	0.2
50	6.0	45.6	24.5	3.6
70	18.8	36.1	40.2	21.0
100	35.2	16.4	24.8	40.2
140	21.7	1.5	7.0	19.1
200	8.8	0.1	2.0	9.1
270	3.5	0.0	1.0	3.6
Pan	2.7	0.1	1.0	3.2
A.F.A. Clay	2.5	None	None	None
A.F.A. Fineness No.	88	51	59	89

Core quality control is an essential factor of quality casting production. Close control of the coremaking process—raw materials, mixtures, core baking and finishing—aid the foundryman to meet increasingly rigid castings specifications.

This paper will be presented and discussed at a Malleable Iron Founding Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6-10, 1946. Oral and written discussion is invited.

Table 2

Core Sand Mixtures

Components	Sand Mixtures "B"	"Bracket"	"Sickle"	"Chain"
Bank Sand, gal.	24	14		
Ottawa Sand "A," gal.	10	20		
Ottawa Sand "B," gal.			34	
Ottawa Sand "C," gal.				34
Cereal Binder, gal.	1	1	1	1
Core Oil, pt.	5	6	6	10*
Kerosene, pt.	1	4	4	4
Water, pt.	5	9	9	10
Mulling Time, min.	4	4	6	6

*Fast drying.

is very important that these be maintained.

Four of the most commonly used mixtures, together with their physical properties, are listed in Tables 2 and 3.

At least 90 per cent of the production cores are made from these mixtures. All four are used either on core blowers or on the bench. The "B" sand mixture is used for approximately 50 per cent of the cores. It produces a core of average hardness and sufficient strength to meet most needs. The "bracket sand" mixture is used to produce cores that require more strength and higher hardness than usual. Cores for mower sickle guards and other applications requiring close tolerances are made from the "sickle sand" mixture. The "chain sand" mixture listed is used on the core blowers to produce cores for a number of different types of malleable chain. A "chain sand" mixture previously used in the plant would not blow satisfactorily, and it was found that by changing the mixture to the one listed, the core blowers could be used. This resulted in a saving in labor for these cores of approximately $10 per ton of core sand used, and greatly increased the quality of the core produced.

Variations Made

However, as in the case of most foundries, variations of these mixtures are made to take care of certain peculiar requirements. The method of making the core, as well as the desired characteristics of the finished core, has a direct influence upon the core mixture.

The use of kerosene in almost all mixtures is a common practice in the plant. It is highly important that there be little sticking in the core boxes. Other materials for prevention of sticking have been tried but, when cost and results obtained are considered, kerosene has proved quite satisfactory. The amount of kerosene used does not greatly affect the dry strength of the cores.

Coremaking

Cores are produced by several different methods. About 75 per cent of the cores are made on core blowers. Because of the nature of the work, most of the cores can easily be made by this method. Sixteen core blowers are operated at 95 psi. air pressure.

Several other coremaking machines of the vibrator type are also in operation. Jolt roll-over machines are used for the production of the largest cores. A small percentage of the production cores are handmade by bench coremakers.

Wherever necessary, aluminum core driers are used, although most of the cores will stand up on plates during baking. The chain cores are not placed on driers, but stand on end, thus producing a rather dense mass on the core plate. For this reason, chain cores receive a double bake by making two trips through the continuous oven.

In a number of instances metal chills are placed in the core box before the cores are formed, and thus become a part of the core. Metal inserts of various types are also used in this manner when the castings produced are to be used as hard iron and in an unannealed condition.

Baking is done, for the most part, in a continuous horizontal-type gas-fired oven. The temperature and time cycle are controlled automatically. The total cycle time is approximately 3½ hours, of which about 1½ hours are spent in the baking zone at a temperature range of 410 to 420° F. The conveyor carrying the cores into the oven passes between two rows of core blowers for convenient loading.

A group of gas-fired, batch-type core ovens is also maintained to take care of the largest cores, and special purposes.

Cores Cooled

As the cores come from the continuous oven they are somewhat above room temperature, and are further cooled on racks before packing. The cores then are inspected and packed onto boards for delivery to the foundry.

Chain cores, cylindrical in shape and varying from ⅛ to ½-in. in diameter and one in. to 3 in. in length, are packed onto boards in an end-to-end manner. The number

Table 3

Properties of Core Sand Mixtures

Properties	Sand Mixture "B"	"Bracket"	"Sickle"	"Chain"
Moisture, per cent	2.9	2.5	1.5	1.5
Green Permeability	90	115	140	34
Dry Permeability	115	150	155	37
Green Comp. Strength, psi.	0.98	0.66	0.14	0.30
Tensile Strength (after baking at 400° F.), psi.				
1 hr.	183	214	263	360
1½ hr.	194	220	255	360
2 hr.	181	200	255	347
(after baking at 450° F.), psi.				
1 hr.	165	185	229	287
1½ hr.	164	172	213	267
2 hr.	142	151	209	273
Collapsibility (20-lb. load at 2500° F.), sec.				
(baked 2 hr. at 400° F.)	198	155	95	268
(baked 2 hr. at 450° F.)	180	125	127	283

of cores in a row depends upon the number of castings produced in a mold. The cores are set with the aid of a scoop that holds one row of cores. This practice greatly facilitates the setting of cores by the molder.

Core Finishing

Because of the type of work produced in the foundry, few cores are sprayed or coated. For the small amount of core pasting that is done, a commercially prepared core paste is used. Where exceptional hardness is required in a particular section of a core, that section of the baked core is dipped in a mixture of core oil and kerosene (one part oil and two parts kerosene) and dried in the continuous oven.

Core Quality Control

As the quality of the castings improves, the control of core quality becomes more essential. The plant endeavors to control the quality of all raw materials used. Sand shipments are checked periodically for fineness and clay content. Each shipment of core oil is sampled and tested for chemical specifications and baking characteristics.

During the mixing of the sand, the moisture content is carefully controlled and mixing time is checked. Needless to say, excessive moisture or mulling time will cause considerable trouble with core blowers. Control of temperature in baking ovens is relatively simple with the controllers and pyrometers available to the industry.

Inspection of the finished cores is done by the packers as the cores are prepared for delivery to the foundry.

This article is not intended to serve as a guide for the successful operation of a core room, but is merely a brief outline of the methods used in one plant. There are many instances in the author's plant where improvements in core practice could be made, and as time and experience indicate these changes are made.

As this is being written the scarcity of cereal binders for core sand mixtures is becoming more and more important. It will soon be necessary to eliminate much of the corn product binders from the mixtures, at least temporarily. An experimental program is now under way, intended to find a substitute that will meet requirements.

A.F.A. Staff Member Honored For War Work

S. C. Massari, who joined the A.F.A. staff as a technical consultant upon his release from the Army, where he served for over three years as a Lieutenant Colonel with the Chicago Ordnance District, was recently awarded the Legion of Merit Medal for his services in connection with war production work, especially in the tank-automotive branch.

The ceremony was conducted in the offices of the Chicago Ordnance District on March 22. The medal was conferred upon him accompanied by the following citation:

"Lt. Col. Silvio C. Massari, Corps of Engineers, Army of the United States, serving in the Tank-Automotive Branch, Chicago Ordnance District, from July, 1942, to December, 1945, used his wide metallurgical knowledge to great advantage in successfully solving many problems affecting a variety of Ordnance items and in increasing and streamlining their production. His achievements were a direct contribution to the war effort."

Prior to his entering military service, Sil Massari was connected with the Association of Chilled Car Wheel Manufacturers, Chicago, for over 14 years as chief metallurgist.

Owing to the illness of N. F. Hindle, Director, A.F.A. Technical Development Program, Mr. Massari has been in charge of the technical program for the 50th Anniversary Convention, May 6-10.

Chicago Plans For Regional Conference

The annual Chicago chapter regional conference will be revived this year, when foundrymen meet November 21 and 22 in a loop hotel to hear speakers at 20 technical sessions.

Co-sponsors with the Chicago chapter of the 1946 conference, are the Central Illinois chapter, Illinois Institute of Technology, Chicago; Northwestern University, Evanston, Ill.; and the University of Illinois, Urbana.

Under the chairmanship of A. W. Gregg, Whiting Corp., Harvey, Ill., a general arrangement committee met recently to start planning the conference. Present were: A. W. Gregg; Prof. R. G. Bigelow, Northwestern University; Oscar Blohm, Hills-McCanna Co., Chicago; Prof. C. H. Casberg, University of Illinois; L. H. Hahn, Sivyer Steel Casting Co., Chicago; T. J. Magnuson, Champion Foundry & Machine Co., Chicago; C. V. Nass, Pettibone Mul-

Lt. Col. S. C. Massari (second from left), technical consultant, American Foundrymen's Association, Chicago, being awarded the Legion of Merit at the Chicago Ordnance District office. Looking on are (left to right) Col. J. H. Holmes, District Chief, Chicago Ordnance District; Gen. Thomas S. Hammond, Whiting Corp., Harvey, Ill., and Past National A.F.A. President, and Col. John Slezak.

liken Corp., Chicago; George A. Pope, *The Foundry;* F. F. Shoemaker, Armour Research Foundation, Chicago; Eugene Smith, Lindahl Foundry, Chicago; and James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.

Mr. Gregg brought out the desirability of continuing the conference series started in 1938 when the first Chicago Regional Conference was held at Purdue University, West Lafayette, Ind. Sponsored jointly with Purdue University, the conference was attended by many interested foundrymen. Some 200 Purdue engineering students also were present at the technical sessions of that year.

The operating foundry exhibit at the Museum of Science and Industry, Chicago, was officially opened at the second regional conference in 1939. Sponsored by the Chicago chapter, the exhibit was developed with the cooperation of foundry equipment manufacturers and foundry suppliers.

There was no Chicago regional conference the following year because the National A.F.A. Convention was held in Chicago in 1940.

In 1941 a conference was sponsored jointly by the Chicago, Central Indiana, and Michiana chapters and Purdue University. Held October 17 and 18, this conference temporarily ended the series, wartime difficulties interfering.

Continuing in 1946, the Chicago Regional Conference will feature four groups of five simultaneous technical sessions. Co-chairmen of the five technical division committees are: Gray Iron, Eugene Smith, Lindahl Foundry, Chicago; and James Leisk, Chicago Hardware Foundry Co., North Chicago; Steel, C. V. Nass, Pettibone Mulliken Corp., Chicago; and L. H. Hahn, Sivyer Steel Casting Co., Chicago; Malleable, G. B. Stantial, Illinois Malleable Iron Co., Chicago; and R. P. Schauss, National Malleable & Steel Castings Co., Chicago; Non-Ferrous, Oscar Blohm, Hills-McCanna Co., Chicago; and William B. George, R. Lavin & Sons, Inc., Chicago; Patternmaking, H. K. Swanson, Swanson Pattern & Model Works, East Chicago, Ind.; and Harry J. Jacobson, Industrial Pattern Works, Chicago.

Annual Trade Group Exhibit in Cleveland

A NUMBER OF THE FOUNDRY TRADE ASSOCIATIONS have accepted the invitation of A.F.A. to be represented at the 50th Anniversary Foundry Show in Cleveland May 6-10 with exhibit space. Their presence thus will add materially to the importance of the 1946 Foundry week and will emphasize still further the fact that progress in the foundry industry during the past half century includes improvement of foundry business practices as exemplified by the policies and activities of the trade associations.

The Gray Iron Founders' Society of which W. W. Coutts, Washington, D. C., is Executive Vice President, is one of the trade groups that will be officially represented in Cleveland. Another is the Non-Ferrous Founders' Society with headquarters in Chicago, the newest of the foundry trade associations. A. E. Pye is Secretary of the Brass and Bronze group.

A. J. Tuscany, Executive Secretary of the Foundry Equipment Manufacturers Association, has advised the intention of that important group to be represented on the exhibit floor. Another relative newcomer to the trade association field, the Magnesium Association, of which T. W. Atkins is Executive Vice President, also will have a display booth to which foundrymen interested in magnesium castings problems can come for advice and discussion.

It has been learned too that the Malleable Founders' Society, of which R. E. Belt is Secretary, will have a headquarters booth in the Foundry Show.

Erie To Have Local Foundry Exhibit

ACCOMPLISHMENTS AND SCOPE of the foundry industry will be demonstrated to the public of Erie, Pa., through a foundry exhibit at the local Y.M.C.A., May 15-17, sponsored by the Northwestern Pennsylvania A.F.A. chapter in collaboration with the Erie Foremen's Association.

Designed, also, to indicate the potentialities of the industry and attract desirable personnel, the exhibition will consist of nine divisions: aluminum, brass and bronze, gray iron, steel and malleable foundries; melting and pouring; technical and testing; pattern shop; and foundry supply.

A chairman selected from the industry represented, will head each division. Douglas James, Erie City Iron Works, Erie, is general chairman for the exhibit.

"Molded in Erie" is the slogan of the project, and material will be supplied by local foundries. However, if necessary to portray all phases of the foundry industry, exhibitors at the National Convention in Cleveland will be contacted and asked to bring some of their material to Erie.

Ladies Entertainment Planned For Convention

THE FEMININE CONTINGENT at the 50th Anniversary Convention is expected to be even larger than in recent years, and has always been one of the most colorful phases of A.F.A. annual meetings. Present indications are that a great many foundrymen will be accompanied by their wives this year and the Ladies' Entertainment Committee of the Northeastern Ohio Chapter has arranged a program of interesting events for each day of Convention Week, culminating in the Annual Dinner on Friday, May 10.

The schedule of ladies' entertainment as now arranged is as follows:

MONDAY, MAY 6—A.F.A. Annual Ladies' Tea, 3:00-5:00 pm, Cleveland Hotel.

TUESDAY, MAY 7—Style Show and Luncheon at a leading department store.

WEDNESDAY, MAY 8—Theater Matinee.

THURSDAY, MAY 9—N.E.O. Chapter Luncheon for visiting ladies.

FRIDAY, MAY 10—Annual Dinner and Dance, 7:00 pm, Grand Ballroom, Hotel Statler.

Ladies' registration headquarters will be established at the Hotel Cleveland on the mezzanine floor, where ladies of the local chapter will be in attendance. Registration should be taken care of promptly on arrival. The usual "ladies' credential cards" will not be issued this year; all arrangements will be made at the ladies' registration desk.

CASTINGS INDUSTRY AIDS

ACADEMIC SCHOOLS

ELEMENTARY AND SECONDARY schools offer two fields for valuable long-range educational activities by the foundry industry. The elementary schools alone, in the United States and Canada, contain some 25 million children, in many of whom an awareness of castings can be created. As school children advance to a point where they become interested in how manufacturing processes are carried on, they should have the opportunity of learning, and perhaps seeing, how castings are made.

The foundry industry can be brought into high school courses in general science, chemistry, physics, economics, history, and geography. In his last year, the pupil usually studies job opportunities and receives counselling in occupation selection. At this stage, castings and their universal application having been kept before the student, information on the nature and variety of jobs offered by the foundry industry must be available, for those who are interested.

Educational Problem

Study of foundry industry needs, and consultation with psychologists, reveal that the problem of cooperation with grade and high schools is two-fold. First, a basic program is required for creating casting consciousness and awareness of the foundry industry at all age levels. Second, there is need for convincing older age groups that the industry offers a good occupational future and greater than average opportunity for advancement.

Both phases of the program are expected to be built around a series of simple, direct pamphlets to be issued by A.F.A. in connection with the Association's Mutual Education Program. These pamphlets are to be suitable for general class room instruction, thus assuring general acceptance by teachers and schools. Interwoven in the general story contained in some of the pamphlets will be information about castings and the industry that produces them. Others will direct attention to the significance of castings to individuals, communities, nations, and the world. In some cases the pamphlets will demonstrate the applications of certain school courses to foundry work.

Additional Activities Needed

Using the proposed pamphlets as a skeleton, the program is expected to be filled out with selected motion pictures, foundry visits, talks by foundrymen, exhibits, and contests. In the lower grades a primitive form of educational medium such as posters could probably also be used. Large, colored pictures of castings and foundries could be used to advantage with the suggested leaflets.

Although the pamphlets are considered a responsibility of the A.F.A. National Office, it is expected that the chapters will determine the nature of and advisability of using supplementary material.

The suggested program of leaflets is expected to be valuable in creating interest in castings and the foundry industry in teachers and parents. Before using a leaflet, teachers certainly will review it to determine its suitability to their classes. Pamphlets given to pupils will be taken home to be read by parents.

Education Begins Early

The foundry education of pupil and teacher can begin at about fifth grade level. Since castings are universally used, the leaflets would need only to point out and discuss briefly the common castings used or seen every day by everyone. A series entitled, for instance, *"Castings in Your Home," "Castings in Dad's Automobile,"* etc., probably would be suitable.

To illustrate, the leaflet tentatively designated as *"Castings in Your Home,"* would show how many castings are used in furnishings and appliances in the average home. Radiators, stove and furnace parts, sinks, bathtubs, water faucets, pipe fittings, many kitchen appliances, cooking utensils, and other common household items are foundry products. An extensive series could be developed, touching on castings in aircraft, agriculture, schools, communications, ships, railroads, bakeries, hospitals, power plants, offices, and innumerable other places familiar to children.

In conjunction with the distribution and use of such leaflets, it would be well for A.F.A. chapters to sponsor trips through foundries for teachers. The teacher would be more receptive to the use of the leaflets, would have an interesting story to tell her class, and would be able to answer pupils' questions with greater ease.

The value of a foundry visit for teachers has been shown clearly by

the Hamilton Foundry & Machine Co., Hamilton, Ohio. A tour of this plant was enthusiastically received by teachers of the Hamilton public school district.

A motion picture illustrating castings and foundry operations might be desirable in some localities. In certain areas it should be possible to take small classes to the foundries, but this would require great care, careful planning, and entail considerable trouble if undertaken in many cities.

In the Chicago area pupils can have the opportunity of seeing a small, mechanized foundry in operation at the Museum of Science and Industry. Illustrating all the basic foundry operations, the exhibit has long been sponsored by the Chicago chapter of A.F.A.

Make Own Molding Equipment

At seventh and eighth grade levels, boys have usually had some manual training courses, primarily woodworking. Elementary foundry practice could be introduced here, possibly as a continuation of manual training. Having learned to handle simple, hand, woodworking tools, pupils could make small flasks and other molding equipment, developing facilities adequate for making small castings of lower melting alloys such as pewter. Directions for a brief-case size art-metal foundry are given in the Oct. 1941 issue of *Popular Science,* pp. 170-174.

If the industrial arts instructor is interested, he can readily establish a small foundry in the corner of his shop, melting and casting aluminum alloys and copper alloys. With supervision, boys of 12 or 13 can do a fair job of molding, using simple patterns.

Schools Sponsor Boy Scouts

Boy scouts may be interested in foundry practice through the Foundry Merit Badge. This badge is earned by few scouts because they do not have the facilities for practicing and passing the required tests. With the cooperation of an A.F.A. chapter, this difficulty might be overcome with the result that the boys' interest in the foundry would be stimulated.

Many schools sponsor boy scout troops and can be encouraged to provide simple foundry facilities suitable for scout use and for school instruction, or may be persuaded to let scouts use existing facilities. If space or equipment is unavailable, local foundries can aid by permitting boys to mold in out-of-the-way areas of industrial foundries. A foundryman on the local troop council would provide the solution to this problem, again to the benefit of both the boys and the foundry industry.

Becoming interested in foundry practice, boy scouts 12 to 17 years old from Winona, Minnesota, operated a foundry exhibit at the Minnesota State Fair, molding and casting bookends. The iron was melted in a cupola made from two oil drums!

Pamphlets, movies and talks by foundrymen, suitable for fifth and sixth grade pupils, could be used in the seventh and eighth grades with little or no modification. Unwise for younger pupils, foundry visits would be possible for seventh and eighth graders.

High School Pupils Look Ahead

Freshmen and sophomores in high school need to be made casting-conscious if they are not already so. Some pupils of this age group may be planning the rest of their high school years with a tentatively selected vocation in mind, or perhaps looking for another school which will fit them better for their chosen work. Pupils expecting to go into the foundry industry as production workers may wish to transfer to a technical high school or vocational school. A.F.A. chapter cooperation with schools of these types was discussed in the March issue of American Foundryman.

The foundry industry could be worked into pamphlets suitable for use in freshman and sophomore courses in general science, history, and geography. A pamphlet for general science might illustrate simple applications of science to foundry practice and of castings to everyday life. A brief historical background of the foundry industry can be made to fit into any high school history course because castings have been important since prehistoric times. Geography pupils study migration of tribes, the course of wars, and the location of mineral deposits and fuel supplies. These have affected the development and location of foundries since earliest times and such considerations are still important.

Parochial schools and classes in religion could use leaflets relating to the role of castings in religious history. Such leaflets also could be distributed to clergymen who would find them interesting and possibly of use as source material for a sermon or other talk.

Pupils Select Vocations

Advancing to the junior and senior years of high school, pupils become increasingly aware of the need for a vocation. They begin to give serious consideration to the ease of getting and holding a job, the possibilities for advancement, the salary, and social prestige related to various types of work. At this stage, particularly for job-counselling meetings and classes in occupation selection, printed information should be available to students and teachers.

Each year, in March and April, many schools hold vocational guidance meetings which representatives of local industries and professions attend, answering questions and advising pupils and parents. This excellent opportunity to cooperate with high schools should be considered by all A.F.A. chapters.

In recommending "the foundry as a good place to work," it should be brought out that besides production workers and material handlers, there are jobs for timekeepers, safety engineers, draftsmen, designers, bookkeepers, carpenters, machinists, electricians, steamfitters, plumbers, chemists, metallurgists, engineers, and many others. In considering skilled jobs in the foundry industry, the student should be reminded that the job outlook for the future is better in occupations requiring training. This information is expected to be brought out in the proposed A.F.A. pamphlet related to jobs in the foundry industry.

Courses in economics, usually taught in the last years of high school, include studies of the economic importance of industries. A leaflet might be written describing the basic nature of the casting industry, its contribution to a community in high living standards, material wealth, jobs for workers, etc. Such leaflet would help teachers, pupils, and the foundries.

Applications of laws and principles of chemistry and physics provide subject matter for two additional booklets. These would indicate the role

that the basic sciences play in the foundry industry.

Motion pictures, visits to foundries, and talks by foundrymen, adjusted to the age level or selected for older high school students, are good advertising for the foundry industry. Whether located in schools, libraries, or museums, exhibits of castings have been especially successful with older students.

The Caterpillar Plan

Caterpillar Tractor Co., Peoria, Ill., has been eminently successful in carrying out a program of cooperation with local high schools. Described in the October 1945 issue of AMERICAN FOUNDRYMAN, this program enables high school students to work in the Caterpillar plant, where they apply knowledge of physics and chemistry and acquaint themselves with castings and foundry operations. The program provides trained personnel for the plant and gives young students early contact with the working world.

Chapter Educational Activities

In some communities civic groups cooperate in producing booklets listing community resources. These booklets are used by teachers in planning field trips to industrial plants, local and federal government offices, museums, airports, markets, terminals, etc. A.F.A. chapters might cooperate in or initiate the preparation of such booklets.

Some chapters have had considerable success with special meetings and functions of the type desired to supplement the proposed series of educational pamphlets. For example, industrial field trips for vocational guidance counsellors have been found valuable by the Northeastern Ohio Chapter. A castings exhibit sponsored by the Twin City Chapter has been in constant demand by academic and vocational schools in Minneapolis and St. Paul since it was started about six months ago.

Vocational training teachers and prospective students were guests of the Western Michigan Chapter at an educational meeting April 11. Designed to attract young men to the foundry industry, the benefits offered through the chapter's "Donald J. Campbell Educational Fund" were explained at this meeting.

An exhibit to show the public the accomplishments, potentialities and scope of the foundry industry is planned for May 15-17 by the Northwestern Pennsylvania Chapter and the Erie Foremen's Association. The exhibit is expected to interest local high school and trade school students in the foundry as a place to work.

Chapters Name Men For Educational Work

NAMES of educational committee members were announced recently by three A.F.A. chapters. Active in chapter educational work, these men are aiding in promoting the national A.F.A. educational program.

Outlined in the January AMERICAN FOUNDRYMAN, details of the program are being presented in a series of monthly articles. The fourth article, discussing foundry educational activities in grade and high schools, appears elsewhere in this issue.

Northeastern Ohio chapter educational committee members, all of Cleveland, are: John H. Tressler, Chairman, Hickman, Williams & Co.; Bruce Aiken, Crucible Steel Castings Co.; J. H. Bruce, Bowler Foundry Co.; Frank C. Cech, Cleveland Trade School; A. C. Denison, Fulton Foundry & Machine Co., Inc.; F. Ray Fleig, Smith Facing & Supply Co.; James G. Goldie, Cleveland Trade School; David B. Kennedy, Glutz Brass & Aluminum Co.; George J. Leroux, National Malleable & Steel Castings Co.; John S. Parker, SPO Inc.; J. M. Price, Ferro Machine & Foundry Co.; V. J. Sedlon, Master Pattern Co.; Walter L. Seelbach, Forest City Foundries Co.; Frank Steinebach, *The Foundry;* Henry J. Trenkamp, Ohio Foundry Co.; Fred S. Wellman, Wellman Bronze & Aluminum Co.; Ralph R. West, West Steel Casting Co., and Ray Wills, Grabler Mfg. Co.

Named to carry out educational activities for the Texas chapter are: L. H. August, Chairman, Hughes Tool Co.; and C. C. Graff, Texas Electric Steel Castings Co., both of Houston.

Northern Illinois and Southern Wisconsin chapter educational work will be conducted by R. W. Mattison, Mattison Machine Works, and Fred Rundquist, Sr., Greenlee Bros. & Co., both of Rockford.

A meeting of the A.F.A. Committee on Green Sand Properties, Foundry Sand Research Project, was held recently in Milwaukee. The committee members discussed present committee activities and made future plans. Members at this committee meeting were (back row, left to right) E. A. Janke, Nordberg Mfg. Co., Milwaukee; Carl Loper, Allis-Chalmers Mfg. Co., Milwaukee, Committee secretary; B. H. Booth, Carpenter Bros. Inc., Milwaukee, Committee chairman; E. C. Olsen, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.; and Wm. Chadwick, Manley Sand Co., Rockton, Ill. (Front row, seated left to right) John A. Van Haver, Sealed Power Corp., Muskegon, Mich.; Charles Cousineau, West Michigan Steel Foundry Co., Muskegon, Mich.; P. C. Rosenthal, University of Wisconsin, Madison; and H. C. Stone, Belle City Malleable Iron Co., Racine, Wis.

FOREIGN FOUNDERS

To Arrive Eager for Convention Data

MANY OVERSEAS foundrymen, along with large delegations from Canada, Mexico and South America are planning to attend the A.F.A. Golden Jubilee Foundry Congress and Show in Cleveland May 6-10, according to advices to the National Office.

Latest advice indicates that the delegation from the Institute of British Foundrymen will include T. Makemson, Secretary of the Institute, serving as Director for Iron Castings, Iron and Steel Control Division, British Ministry of Supply; G. W. Bush, Renshaw Foundry Ltd., Middlesex; J. Dearden, L.M.S. Railway Co., Derby; V. Delport, Penton Publishing Co., Ltd., London; Basil Gray, English Steel Corp., Sheffield; A. Jackson, Garton & King, Ltd., Exeter; T. Lee, Henry Hollingdrake & Son Ltd., Stockport; D. L. Menzies, North British Steel Foundry Ltd., Edinburgh; F. W. Nield, Henry Wallwork & Co., Ltd.; E. Owen, Walmsleys Ltd., Bury; T. Shanks, Cruikshank & Co., Ltd., Denny, Scotland, and F. E. Tibbenham, Suffolk Iron Foundry Ltd., Suffolk.

British Group Large

Also expected to register from Great Britain are M. Royce of Tipton, sponsored by the British Ministry of Supply; J. G. Pearce, Director, British Cast Iron Research Association, and his colleague, W. J. Driscoll; A. B. Lloyd, F. M. Lloyd & Co., Ltd., Wednesbury, and C. W. Coleman, Letchworth.

Nine representatives of Swedish companies and associations are said to be planning to attend. They are Yngve Granstrom, Foundry Manager, ASEA Foundries, Vasteras, and Secretary, Swedish Foundrymen's Association; E. O. Lissell, editor of the Swedish foundry manazine "Gjuteriet" and Chief, Foundry Division, Mekanforbundet, Stockholm; Jorgen Drachmann, Foundry Manager, Scania-Vabis Motor Co., Sodertalje; Isak Forslund, Chief Metallurgist, SKF Industries, Latrienholm; Alvar Huldt, Foundry Manager, Domnarfvet Iron & Steel Works, Domnarfvet; Thomas Lewander, Civil Engineer, Hugo Montgomery AB, Stockholm; Stig Ljunggren, Foundry Manager, Kohlsva Iron & Steel Works, Kohlsva; Hans Rudberg, Research Director, A/B Jarnforadling Halleforsnas, and Stig Sylvan, Chief Engineer, A/B Svenska Flaktfabriken, Stockholm.

French Groups Represented

Expected to represent French foundries, associations and government organizations are P. Bastien, President, Association Technique de Fonderie; Robert Boutigny and Fernand Modro, engineers of Societe Stein & Roubaix; Maurice Cuni, Engineer, Ecole Polytechnique, and Jean Laine, Engineer, Ecole Centrale and Ecole Superieure de Fonderie, representatives, with Mr. Gallais, of the French Ministry of Industrial Production, all of Paris; Robert Ronceray, General Manager, Ph. Bonvillain & E. Ronceray, Seine; and Messrs. DeBrock and Dureuil, whose connections are not indicated.

Many Countries Interested

Others expected from overseas are J. Sissener, Consulting Engineer, A/S Myresn Verksted, Oslo, who is General Secretary of Norway's Polytechnical Engineering Society; W. A. Gibson, Consulting Engineer, Sydney, Australia; M. Borgerhoff, Engineer, AILg, a director of Association Technique de Fonderie de Belgique, and Marcel Remy, also of Liege; Pol Boel, Usines G. Boel, Brussels; Paul Ropsy, Administrateur Delegue, Societe Belge Griffin, Antwerp, and Dr. L. Jenicek of Prague.

Informal Shop Groups Present Full Program

AMONG THE MOST POPULAR and well-attended meetings at annual meetings of the Association are the informal shop operation courses, where the discussions get down-to-earth and are conducted with the intent of providing practical shop information for the men "on the firing line." Off-the-record privacy is observed at these sessions, and the questions and answers as may be reported are not attributed to the individuals who voice their ideas or seek information in regard to specific aspects of foundry sciences.

Two shop courses are on the 1946 program, one a 4-session Gray Iron Shop Course, the other a 5-session Sand Shop Course, the latter concentrating this year on sand control practices.

The Gray Iron Shop Course sessions are scheduled for the afternoons of May 6, 7 and 8, and the morning of Thursday, May 9. Two sessions will deal with cupola operations, and two with castings defects, a subject on which intensive work has been carried on by the Castings Defects Committee.

Subjects and Group Leaders

Monday's subject is Metallurgy of Cupola Mixes, with K. H. Priestley, Eaton Mfg. Co., Vassar, Mich., leading the discussion. Members of the Castings Defects Committee will handle, on Tuesday and Wednesday, the discussions of Castings Defects Attributable to Metal. Thursday's subject is Metallurgy of Carbon Control in the Cupola, with the discussion led by R. A. Clark, Electric Metallurgical Co., Chicago.

Three of the Sand Shop Course meetings have been set up as evening sessions, giving local plant men an opportunity to attend. Monday's subject is Magnesium Molding Sands, with Oscar Blohm, Hills-McCanna Co., Chicago, the discussion leader. On Tuesday, Malleable Molding Sand Control will be taken up, and two discussion leaders will handle the topic: E. C. Zirzow, National Malleable & Steel Castings Co., Cleveland, and L. Richard Spann, Eastern Malleable Iron Co., Naugaruck, Conn.

W. M. Ball Jr., Magnus Brass Div. of National Lead Co., Cincinnati, will conduct the discussion of Brass and Bronze Sand Control, Wednesday afternoon. Gray Iron Sand Control, the subject of the Thursday evening shop session, will be discussed by two men: H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y., and T. W. Curry, Lynchburg Foundry Co., Lynchburg, Va. The final sand shop session, Friday morning, deals with Steel Foundry Sand Control, and E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit, is the discussion leader.

NONDESTRUCTIVE INSPECTION OF CASTINGS

Intelligent application of nondestructive test methods, old and new, by trained inspection personnel working with sound acceptance standards enables the foundry to determine exact locations of defective areas, change foundry techniques to eliminate them, and produce quality castings at lower cost.

Clyde L. Frear
and
Robert E. Lyons
Bureau of Ships, USN.
Washington, D.C.

In general, nondestructive testing includes any method of inspection, practicable or impracticable, efficient or inefficient, which will disclose the presence of defects in a part without destroying the part itself. When applied to castings, the definition may be extended to cover those methods which, while they may remove part of the casting, leave the final part retaining its specific dimensions and still usable.

Examples of such a method are drilling out bosses and removal of extraneous metal such as padding and risers which were added to provide feeding, thus exposing areas which upon visual examination may give some idea of the soundness of the underlying metal.

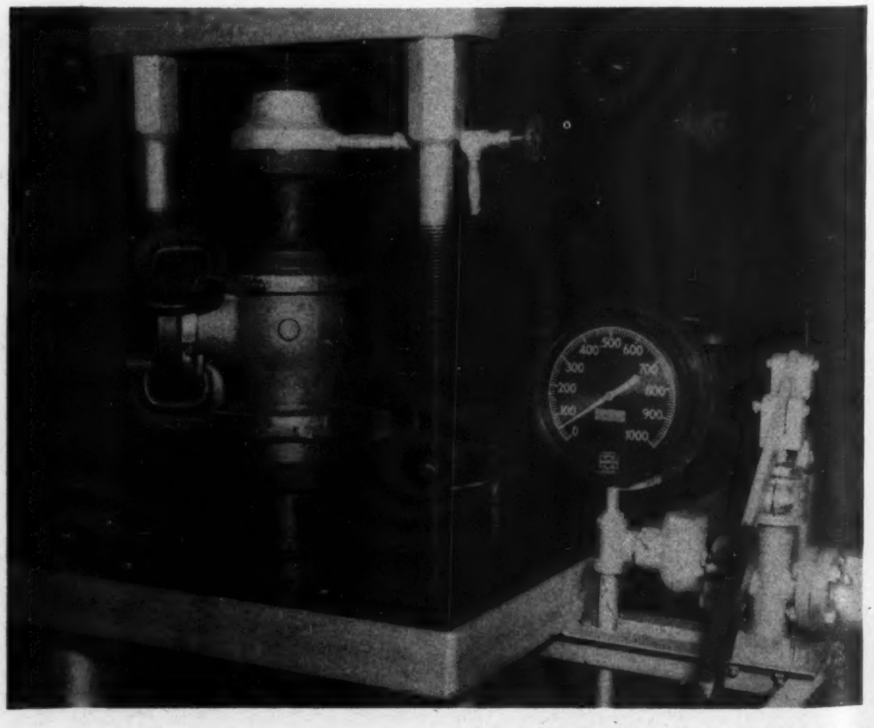
A thorough inspection of castings should be capable of determining the presence of internal as well as external defects, and provide a fairly complete knowledge of the extent of such defects. In the past, surface quality has often been an important factor in determining the acceptability of castings, and much development work has been carried out to improve the surface appearance. To the dismay of a number of foundrymen who have prided themselves upon the excellent finish of their castings, defects have been disclosed upon subsequent machining or pressure testing.

A fine finish is important in many items, among which are statuary, name plates, medals, hardware, etc., but is certainly of secondary importance when the casting is to resist pressure or heavy loading stresses. In such cases the major effort should be exerted in obtaining internal integrity which, in many cases, can be obtained only at the expense of surface appearance.

It becomes necessary then to provide some method of inspection which will show just what is inside the casting and permit of an accurate interpretation of the amount and extent of any discontinuities and their probable effect upon the final serviceability of the part. For years foundrymen have been sectioning castings to determine their internal soundness.

This is far from being a nondestructive test and, although it shows defects present in the area sectioned, it does not indicate the quality in any other area. The writers know of one case where a casting apparently was sound, as shown by sectioning, yet a large shrinkage cavity extended to within

Fig. 1—Typical arrangement of apparatus for hydrostatic testing of valves and fittings (3½-in. bronze angle valve under test).



This paper will be presented and discussed at an Inspection of Castings Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6-10, 1946. Oral and written discussion is solicited. The opinions expressed in the paper are those of the authors and not necessarily those of the Navy Department.

less than ⅛-in. from the cut and was missed entirely by the sectioning. Certainly as a method of correcting foundry technique the sectioning described was useless.

Although sectioning, or fracturing, is a valuable method of inspection in many cases for the correction of foundry technique, it is absolutely useless in checking those accidental defects which often occur despite the care used in the foundry and the standardization of technique.

Nondestructive Inspection Methods

Nondestructive inspection methods may be considered to include the following:

1. Visual inspection.
2. Sound or percussion tests.
3. Impact tests.
4. Pressure tests.
5. Radiographic examination.
6. Magnetic inspection.
7. Electrical conductivity.
8. Penetrants.
9. Supersonics.

A brief description will be given for each method and an attempt made to outline the advantages and disadvantages of each. No attempt will be made to list all methods which might be made to serve as nondestructive tests, nor to list many of the newer tests which are in a developmental stage. All methods listed are in regular use in one or more foundries.

Visual Examination. Visual inspection constitutes the oldest and most widely used inspection method in existence. In fact, it is so extensively used that many forget to list it as an inspection method. Its importance will become even more apparent when it is considered that the success of most of the nondestructive methods described in the following paragraphs depend upon visual inspection for interpretation.

As the name implies, this method consists of examining the surface of the casting with the unaided eye, the use of a hand lens or, in certain cases, low-power microscopes. The number of surface defects which may be found by a trained inspector but which might not be located by the ordinary observer is sometimes surprising.

Among the types of defects which are found by visual inspection are "burned-in" sand, blows, rat tails, cold shuts, swells, surface porosity and surface cracks. The hot tear is another important defect which is commonly considered as internal. Many of these, perhaps all of them, extend to the surface and may be picked up by visual inspection, unless the tear or crack is too narrow to be observed.

One of the most important uses of visual inspection is to determine whether a casting is within the specified dimensions. No details of this use need be given as the subject has been covered by papers previously presented to the Association.

Numerous defects which ordinarily are internal become exposed during machining. It is rather late to discover the presence of defects at this point, especially if the discovery is made after the finish machining operation has been completed. A number of metals, of which steel is an outstanding example, when found to contain defects after machining, can be repaired by welding or other suitable means, especially if a machining cut is still to be made.

Welding operations usually cause a small amount of warpage and, if the part is to be finished to close dimensional tolerances, every effort should be expended to determine the presence of any harmful defects and make necessary weld repairs before the finish machining operation.

This is true even when the repair is made in an unfinished area of a casting which has already been machined to dimension, as the heat from the welding operation may cause sufficient warpage to make the part useless because of misalignment of the finished areas. Added to this, stress-relief heat treatment, often necessary after weld repairs have been made, may injure finished surfaces sufficiently to make the use of the part impracticable.

Internal Flaws

Valuable and necessary as visual examination is, it will not take the place of inspection methods which will show the presence (or positive absence) of internal defects. However, it is necessary that the inspector, to be capable of correct interpretation of nondestructive test results, must have thorough training in locating defects and recognizing them as such.

Many inspectors evidently have lost sight of the fact that it is just as much their duty to accept satisfactory material as it is to reject material which is not suitable for the purpose intended. It is always easier, when in doubt, to reject a part, and if such doubt does exist perhaps rejection is the only answer, at least until such time as this doubt can be removed.

With training and experience the inspector will become more certain of himself and will be able to accept a greater percentage of parts without endangering their usefulness in service. It should be the chief purpose of the various methods to remove, insofar as possible, the doubt which may exist in the inspector's mind as to whether a part may be accepted, repaired, or rejected without qualification.

Sound or Percussion Tests. Next to visual testing, the sound or percussion method probably is the oldest method of inspecting for discontinuities without destroying the part. A number of variations and refinements of the method have been made, but basically it consists of suitably supporting the part or suspending by chains or other equipment, permitting the part to swing free of the floor and other obstructions, then tapping with a hammer.

Weight of the hammer blows must be selected and adjusted to set up vibrations in the part, thus producing a certain characteristic tone which may or may not be changed in pitch or quality by the presence of discontinuities which tend to change the wave length of the sound produced by the blows.

Limitations

This test is analogous to the testing of china and porcelain ware for cracks by tapping with a pencil or the fingernail. Such a method may serve to detect relatively large discontinuities in otherwise homogenous metal, and probably would be successful to a certain extent with forgings having simple shapes and fairly uniform cross sections.

On the other hand, it is not difficult to imagine relatively large internal defects which extend in certain directions but which would not alter the length or quality of the sound vibrations set up in the piece, in which case no indications of the defect would be noted.

Most castings are complex in shape, which in itself may hinder the production of a pure tone upon being struck with a hammer. The

Fig. 2—High pressure steel fitting under steam test.

orientation of the crystals will also tend to dampen the tone.

Considering the harmless discontinuities which may exist in a large percentage of castings, all of which may have an effect upon the character of the vibrations, it can be expected that a relatively large internal defect might be required to change the tone sufficiently to be detectable by the ear with sufficient selectivity to distinguish between a harmful defect and one which would not be harmful, and to determine whether such a defect is located in a highly-stressed area.

The use of a stethoscope for locating abrupt changes in the tonal quality has been recommended, but even by this means it is doubtful if a small but harmful defect could be detected with certainty. In general, such a method would not be suitable with the metals having high damping characteristics.

Impact. As a method of nondestructive inspection, testing by impact must not be confused with the commonly known impact tests such as the Charpy and Izod tests, which require a specimen to be broken during the test. One form of nondestructive impact test would be an extension of the sound test described in the previous paragraph, the only difference being that larger hammers are used and heavier blows are struck.

Whether or not it may be considered as a nondestructive test often depends upon the amount of energy expended in the blows. Another version of the impact test, the drop test, consists of dropping the casting from a certain specified height, usually onto a steel or other solid plate of certain specified thickness and weight.

The expected value of such a test is the hope that all castings which contain harmful defects will break and be rejected automatically, and that those containing no defects will withstand the impact of the drop and be passed as acceptable.

Observations

However, instances have occurred in the experience of the writers where castings have been accidentally dropped from heights of less than that specified and onto wood blocks or concrete floors and suffered breakage in areas having no defects. In other instances, castings have successfully passed the specified drop test only to be put into service and break under loads considerably lower than those exerted in the test.

In this latter case, small defects already present in the casting probably withstood the test, but increased sufficiently under the influence of the impact stresses to lower the strength of the part to a point considerably below that required to withstand the stresses applied in regular service.

Another form of the test consists of dropping a specified weight from a predetermined height upon selected portions of the casting. This form of test is an improvement over the regular drop test in that the application of the load is under better control.

However, this does not eliminate the chance of breakage or propagation of defects. It has taken only a few instances of breakage similar to that described in the foregoing to make the writers believe that drop tests and other forms of impact tests are not to be trusted as acceptance tests for castings, and in many cases may do more harm than good.

In those cases where such a test is considered necessary, the tests should be followed by others capable of determining the presence of discontinuities which may have resulted from the impact stresses.

Pressure Testing. Pressure tests are used to locate leaks and to test the over-all strength of parts such as valves, fittings, boilers, etc., which are to carry fluids in service, and may be divided into hydrostatic, steam, and air tests.

Hydrostatic testing consists of sealing all openings in the casting except a small opening for the introduction of a water pipe and another for a vent, the latter opening being as nearly as possible at the highest point in the casting.

A vent is provided in order that all air may be removed from the part before the application of the pressure. The part then is completely filled with water and the pressure gradually increased to a specified point, which usually is one and one-half or two times the pressure for which the casting is designed.

For obvious reasons where leaks are suspected, the pressure should be applied slowly. Fig. 1 shows a typical set-up for hydrostatic testing of valve bodies and fittings. The illustration shows a 3½-in. bronze angle valve under test.

It will be noted that the inlet and bonnet openings of the valve body are closed by rubber gaskets, the necessary pressure to prevent leakage around the gaskets being applied by a large screw passing through the yoke shown at the top of the photograph. This screw is operated by

means of a hand wheel located above the yoke. The outlet is closed by a gasket and steel plate held in place by C-clamps.

The small valve shown at the top center is opened and water is pumped into the casting under test by means of the hand pump shown at the lower right. When water flows from the valve at the top, showing that all air has been forced out, the valve is closed and pumping continued until leaks are found in the valve body, or until the specified test pressure is indicated on the gauge.

With the test pressure being applied, the casting is carefully examined for small leaks and their location. If the operator has been successful in obtaining an absolutely tight system, with no leakage around the gaskets, through the pump or in the piping, then even a very slight leak or seepage will be indicated by a dropping off of the pressure shown on the gauge.

General Considerations

As fluid pressure is exerted in all directions, the hydrostatic test gives a measure of the over-all strength of the casting. Little or no chance of danger to personnel exists should the casting fail under the test pressure.

Water being almost incompressible, any enlargement of the part undergoing test will cause an instantaneous reduction or relief of the pressure, thus preventing shattering of the part. For this reason, application of pressure by a high-speed pump should be avoided. A small hand pump is preferred for this purpose.

In addition to testing for over-all strength, the hydrostatic test will locate individual leaks through the wall. The action of these individual leaks has given rise to the expressive but not highly accurate terminology of weepers, seepers, leakers and squirters.

The hydrostatic test shows overall strength and the presence of leaks only *at the time the test is made,* and gives no real assurance that the part will continue to be free from defects in service. Cases have been known where a casting was shown to be sound by a hydrostatic test and, when the pressure was removed, the casting leaked under a reapplication of the testing pressure.

It is well known that most foundries desire, insofar as possible, that no machining be performed on the pressure parts of castings, and almost insist upon one unmachined surface in order that an unmachined skin will be left to resist the pressure, the interiors of most castings being less dense than the outer layers.

Another consideration is the fact that most castings are considerably overdesigned, not only to provide a generous factor of safety but to obtain walls which are sufficiently heavy to be run successfully. With this last in mind, it is easy to understand that a shrinkage defect which may occupy as much as 75 per cent of the wall thickness might not manifest itself as a leak under the specified pressure test.

Many shrinkage cavities appear to be smooth-walled when the casting is sectioned, and have been considered harmless provided that sufficient metal has been left in the wall to give the necessary strength.

However, close examination under the microscope has shown that many of these apparently smooth-walled cavities are filamentary in character, and sometimes these filaments have the characteristics of fine hot tears or cracks which extend almost through the casting wall.

Stress Variations

When such a casting is subjected to high-pressure steam or to alternate high and low pressures, the effect of the expansion due to heat or the straining of the walls under pressure may sooner or later cause the filamentary shrinkage cracks to extend, thus causing the defect to reach entirely through the wall. This phenomenon probably accounts for many of the leaks in pressure lines which have developed in service in parts which withstood pressure tests.

This fact should not be considered as condemning pressure tests, but is given as one explanation of something which has occurred many times. The writers are in favor of pressure tests on pressure castings, in conjunction with other nondestructive tests, as these tests most nearly approach actual service conditions. They wish only to point out

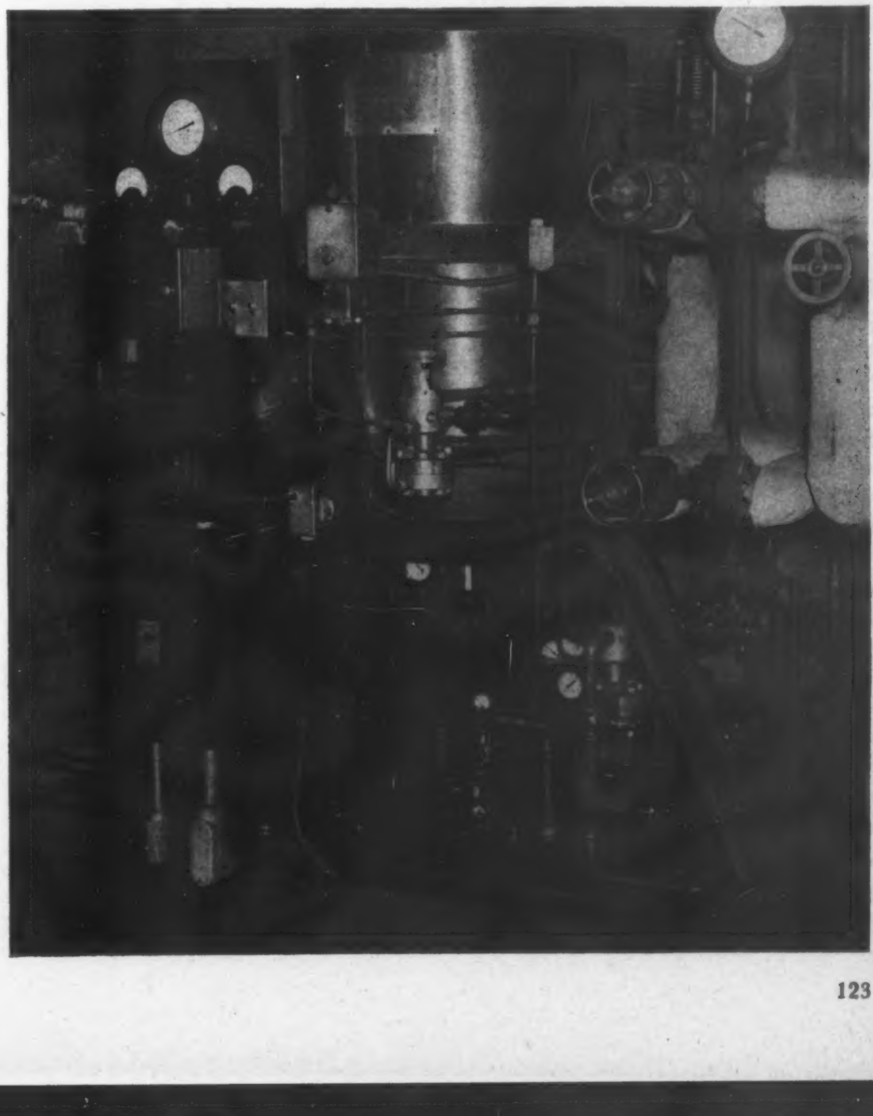


Fig. 3—Automatic boiler used in steam tests

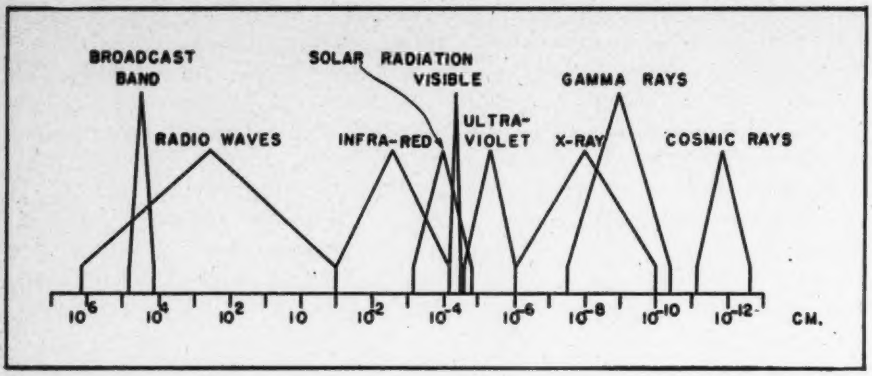


Fig. 4—Electromagnetic radiation diagram.

that no single test will give complete assurance of absence of harmful defects.

Steam Tests. When fittings, valves, etc., are to withstand high pressure steam service, a steam test is often applied. In most ways such steam tests are no better than hydrostatic tests except that the steam, being at high temperature, has a tendency to expand the metal and open up small defects which might have been missed by the hydrostatic test.

In addition, steam and other gases will pass through very small openings more rapidly than will liquids. Steam tests should be used only as adjuncts to hydrostatic tests, and should never be applied until the part has been hydrostatically tested at considerably higher pressure than the steam pressure actually applied in the test.

Because of high compressibility, steam (and other gases) will retain most of its pressure after considerable enlargement of the part, and any slight reduction in pressure may be built up again in a short time. The high pressure acting on the weakened walls of the part under test may cause breakage with sufficient violence to injure personnel by flying pieces or scalding.

Figure 2 shows a steam test being made on a steel "Y" casting for high pressure steam service. Although any source of high-pressure steam which may be available is suitable for this purpose, the automatic boiler illustrated in Fig. 3 is convenient for producing a continuous supply of steam under any predetermined pressure for any desired time with but little attention from the operator.

Air Tests. Testing with air is an adaptation of the hydrostatic and steam test, and is conducted in the same manner except that air is used in lieu of water or steam. In general, it is simpler to apply and requires comparatively inexpensive equipment, and because of its convenience is used to a great extent in the production inspection of small valves and fittings, especially those which are to operate under comparatively low pressures.

However, it may be used with larger parts, especially in those cases where a few pieces are to be tested and no regular equipment for hydrostatic testing is available. Small parts are usually tested by immersion in water or other suitable liquid. The air pressure is then applied internally and the air seeps through any openings in the part and forms bubbles of air on the surface, thus permitting ready location of leaks.

Instead of immersing the part in a liquid, which would be inconvenient with large parts, soap solution may be spread over the surface with a brush. Leaks will then be found by observing bubbles and frothing of the solution where air passes through the wall.

Radiographic Examination. Radiography was the first development which provided a means of actually looking through castings or other opaque materials and determining the presence of internal discontinuities and, in certain cases, heterogeneity of the material. Although it is 50 years since Roentgen discovered the ability of certain rays to penetrate metal, it was not until the 1930's that sufficiently powerful equipment was developed to make the use of x-rays practicable for inspecting castings.

Concurrent with the development of industrial x-ray equipment, the Naval Research Laboratory developed the use of gamma-rays emitted during the decomposition of radium and radium salts as a means of inspection.

These rays, which will penetrate materials commonly considered as opaque, are not mysterious if it is realized that opacity to light is merely the property of absorbing light rays to the extent that the rays are not transmitted through the material.

Characteristics of Short Waves

Many materials which are commonly considered as opaque become transparent in thin sections, a typical example being gold. With this consideration in mind, opacity becomes a comparative term, and it is readily conceivable that it might be possible to generate light rays to which ordinarily opaque materials would become transparent.

X-rays and gamma-rays are electromagnetic rays having wave lengths of approximately 10^{-6} to 10^{-10} cm. Light rays visible to the eye have considerably longer waves, their wave lengths lying between approxi-

Table 1

RADIUM DECOMPOSITION PRODUCTS

Name	*Type of Radiation ( ) = Weak Radiation*	*Half Life Period*
Radium	Alpha (Beta and Gamma)	1,590 yr.
Radon (niton, or radium emanation)	Alpha	3.825 days
Radium A	Alpha	3.05 min.
Radium B	Beta (Gamma)	26.8 min.
Radium C	99.97 per cent Beta and Gamma	17.9 min.
Radium C′	Alpha	Cal. 10^{-6} sec.
Radium C″	Beta	1.32 min.
Radium D (radio lead)	(Beta and Gamma)	19 yr.
Radium E	Beta	4.9 days
Radium F (Polonium)	Alpha (Gamma)	140 days
Radium G	—	—

mately 10^{-1} and 10^{-4} cm. (Fig. 4). As the lengths of these electromagnetic waves become shorter their penetrating power increases until, finally, they are able to penetrate objects opaque to ordinary light waves.

For the sake of emphasis it should be repeated that opacity and transparency are only relative terms. Thus a thick piece of glass would tend to be more opaque and less transparent than a thinner piece of the same glass, which is the same as saying that the thick piece would absorb more light rays than would the thinner piece.

Extending this reasoning, a piece of smoked glass or a lens from a melter's goggles would absorb more light than would a piece of clear glass of the same thickness. X-rays and gamma-rays follow these same rules. With thicker metal, more rays are absorbed and fewer pass through; also, the more dense the metal as measured by its specific gravity, the less the penetration of the rays.

Consider a piece of metal plate which is apparently sound by visual inspection but is known to contain a localized shrinkage defect in the center. If this plate is exposed to x-rays or gamma-rays, some of the rays striking the plate will be absorbed by the metal and stopped in their path, the remainder passing through.

Radiographic Indications

Because of less metal where the shrinkage occurs, more rays will pass through the plate at this spot. Rays passing through cannot be seen as they are invisible to the eye. However, they will cause a fluorescent screen to glow, the intensity of the glowing being proportional to the intensity of the rays striking the screen.

Therefore, examination of this screen discloses the location of the defect by the presence of a brighter spot. The silver coating of a photographic film will absorb a certain number of the rays passing through it, the number absorbed being proportional to the number striking it.

These absorbed rays have an effect on the film similar to that of light. Therefore, if a film is placed against the metal plate on the side opposite to the source of the rays, the rays passing through the plate and then through the film will affect the film

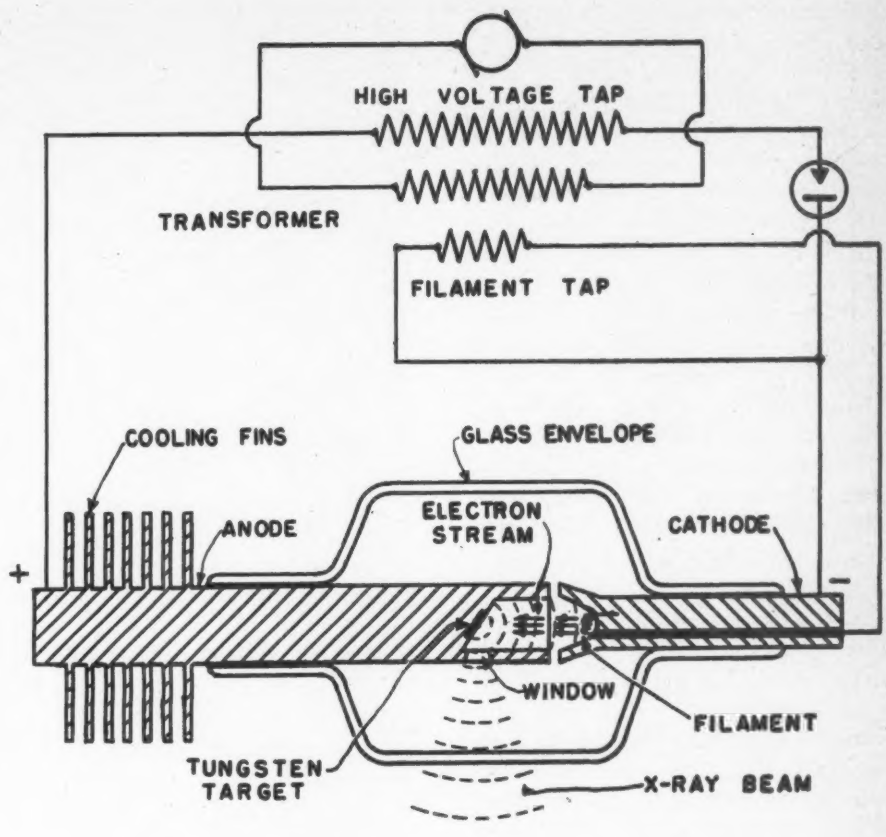


Fig. 5—Construction diagram of simple x-ray tube.

to a greater extent immediately under the defect through which the greater number of rays penetrated.

If this exposed film is developed, it will show darker in that area where the defect was located. It becomes evident, therefore, that internal defects in a casting can be located by the passage of x-rays or gamma-rays through the casting and recording the intensity of these rays upon a photographic film.

Special films with an emulsion coating on each side have been developed for radiography, thus permitting greater ray absorption than single-coated films and hence recording the presence of defects with greater assurance and shorter exposure time.

Radiographic examination includes the use of x-rays and gamma-rays; also, the use of a few other materials which emit rays capable of penetrating heavy materials. Whether x-rays or gamma-rays are used depends upon the availability, power of the equipment, type and size of the material being tested, portability of the equipment, and often upon the convenience.

To a certain extent the two sources are interchangeable, but each has certain advantages and disadvantages which should be thoroughly understood, especially when deciding upon the purchase of equipment.

X-rays. These rays are produced by the impact of electrons upon a target, part of the mechanical energy resulting from the motion of the electrons being changed to energy in the form of electromagnetic waves.

Figure 5 shows a simple form of x-ray tube, which consists of a copper anode and cathode sealed into an evacuated, heat-resistant glass bulb. The inner end of the cathode is cup-shaped and is provided with a small, coiled tungsten filament, one lead of which is insulated from the cathode itself.

In operation this filament is heated by passing a current under an emf. of approximately 12 volts taken directly from a special step-down transformer or from a low-voltage tap from the main power transformer. The passage of the current and heating of the filament causes a build-up of electrons around the filament.

Electrons are negatively charged and have a certain small mass or weight. The outer end of the anode

is arranged for cooling, and the inner end adjacent to the filament is provided with a small tungsten insert or target. When a high-voltage direct current of the order of 50,000 to 250,000 volts is impressed on the tube as indicated in the diagram, the negative charge on the cathode rejects the electrons which surround the filament.

If the filament current continues to flow, electrons are continually formed and rejected by the high-voltage negative charge. The negatively charged electrons are held to a relatively straight and narrow path because of the opposition of the negatively charged cathode cup.

After traveling across the space separating the cathode and the anode, the electrons strike the tungsten target where their motion is suddenly stopped and their kinetic energy is converted, mostly into heat which is conducted through the cooling fins. Remaining energy is converted into electromagnetic waves which, theoretically, leave the target in all directions.

The X-Ray Beam

Most of the unwanted rays are absorbed by the metal of the anode and cathode, and often by lead which surrounds the tube. A "window" is provided to permit certain of the rays to leave the tube in the form of a cone or pyramid, depending upon the shape and location of this window, which is designed to give a beam of the desired dimensions. By manipulating the tube, the x-ray beam can be aimed in any desired direction.

The number of electrons emitted from the filament is proportional to the amount of current (usually measured in milli-amperes) impressed across the tube, and it follows that the intensity of the rays is also proportional to the current. The speed of the electrons is increased with increase of voltage (usually measured in kilovolts).

As the speed of the electrons is increased the wave lengths of the x-rays produced become shorter. In short, the wave length is inversely proportional to the voltage.

Sensitivity, or the ability to register small defects, is dependent upon the wave length of the x-rays, the greater the wave length, the greater the sensitivity. It would appear from

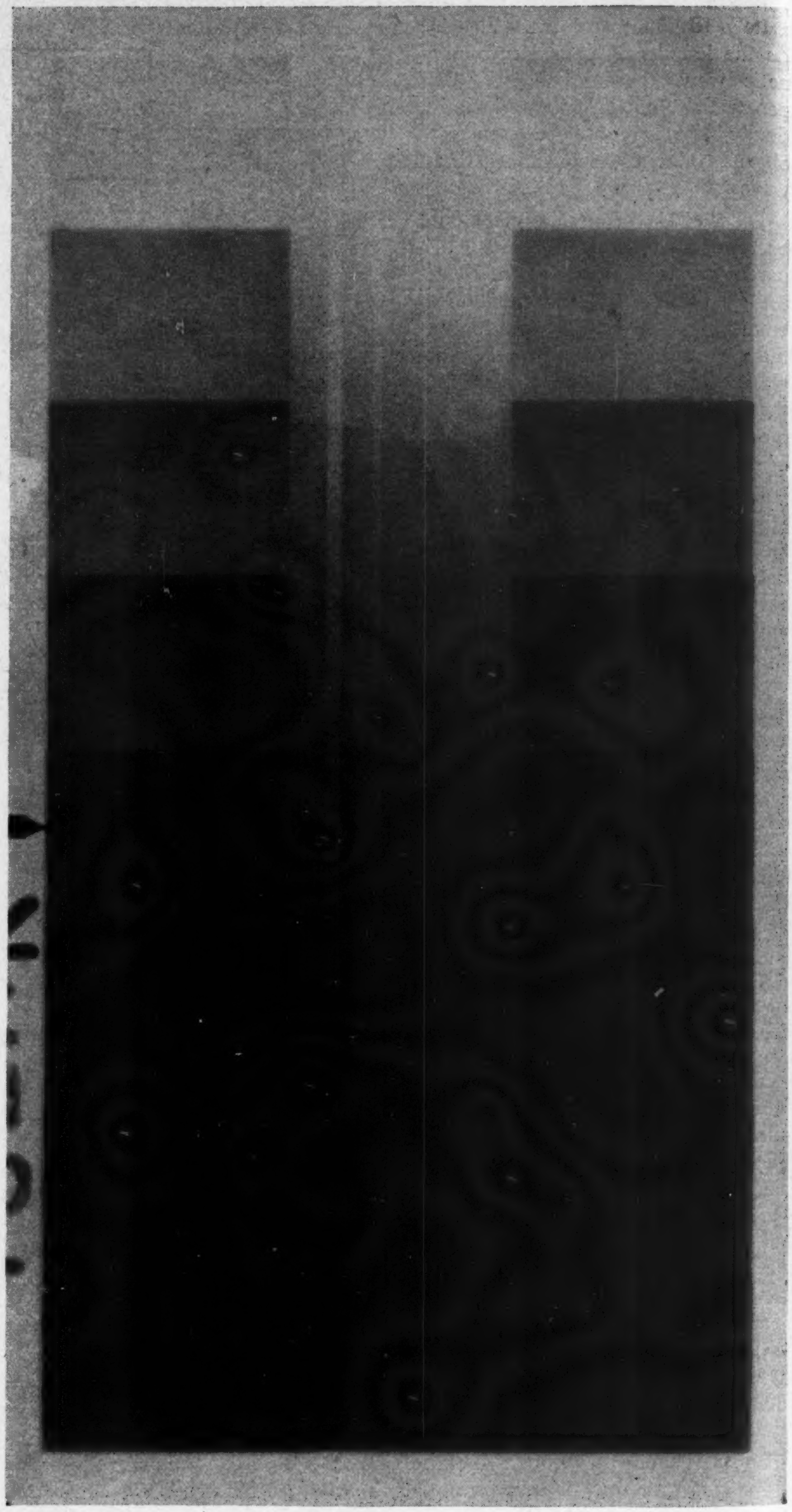


Fig. 6—X-ray radiograph of 1/8 to 1 in. stepped test block. Radiograph made using 185 kv. and timed for 5/8-in. section. Note: High contrast, and lack of detail at thin section (top) and heavy section (bottom); also, sensitivity indicated by clear rendition of milled slots at midlength.

Fig. 7—Gamma-ray radiograph of same block shown in Fig. 6. Radiograph made using 500 milligrams of radium. Note: More uniform density and lower contrast by comparison with Fig. 6; also, decreased sensitivity indicated in less pronounced rendition of milled slots.

this that low-voltage x-rays should always be used for assurance of finding the smallest possible discontinuities, but other factors must be taken into account.

Probably the most important from a production standpoint is the fact that there are limits in thickness that rays from a particular voltage source will penetrate. Equipment of 150 kvp. (kilovolt-peak) is not of much use with steel thicknesses above one in. but is suitable for aluminum and magnesium of greater thickness.

Equipment rated at 220 kvp. is suitable up to 3 in. of steel, but above this the exposure time becomes excessive. Rays from 1000-kvp. equipment can be used practically up to 6 in. of steel, and often up to 8 in. or somewhat higher. Machines operating at 2000 kvp. have been introduced on the market, and can be used with considerably greater thicknesses.

Another difficulty is encountered in the use of low-voltage x-rays, especially in the inspection of castings. Few castings are uniform in cross section, and when radiographing nonuniform sections the problem of density and contrast enters.

Exposure Factors

Contrast can be defined simply as the difference in darkening of the film caused by the rays passing through a defect as distinguished from that caused by rays passing through the adjacent sound metal. Up to a certain point, contrast is synonymous with readability. Films from low-voltage x-rays should have more contrast than those from higher voltages.

However, if a wedge ⅛-in. thick at one end and 2 in. thick at the other is radiographed with a single exposure using 150 kvp. x-rays, the length of exposure (expressed in milliampere-seconds) being calculated for the average thickness, the image of the thin end of the wedge will be too dark to be readable with any illumination of the film, while that of the thick end will be so light that no defects will show.

Figure 6 illustrates this to a certain extent. In this case an x-ray radiograph, known as an x-ograph, has been made of a 4x8-in. steel plate which is one in. thick at one end and tapers by ⅛-in. steps to

Fig. 8—X-ray head, 140 kvp. Transformer is separate from head necessitating high voltage cables.

⅛-in. thickness at the opposite end. A slot 1¼ in. wide has been milled across these steps in order to obtain a continuous taper from one-in. to zero thickness lengthwise of the plate.

In this tapered surface have been milled slots measuring 0.01x0.01 in., 0.02x0.02 in., 0.04x0.04 in., and 0.08 x0.08 in., which serve to show the sensitivity which is obtained at any thickness along the plate. This radiograph was made using 185 kv. and shows best rendition of the milled slots midlength of the block, the exposure having been adjusted for the ⅝-in. section.

Although the density obtained at the thin end of the block is not too great to be read by high intensity illumination, little or no detail can be noted by ordinary illumination. The same is true with the heavy end where the radiographic density is too low to register any but large defects. In the midportion of the block, the 0.01x0.01-in. slot is easily seen on the original radiograph, indicating better than 2 per cent sensitivity.

Increased Penetration

By using rays with shorter wave lengths (those produced by higher voltages), this difference in densities between thick and thin sections becomes less. In other words, the "latitude" increases with decrease in the wave length. Latitude and contrast may be considered as inverse to each other.

If it is desired to gain latitude, a loss in contrast will result. In the radiographic examination of castings, the x-ray equipment selected must be a compromise between certain advantages and disadvantages and capable of operating under voltages which will penetrate the metal being tested in a reasonable length of time; also, which will give sufficient latitude in the range of thicknesses to be examined.

Gamma-Rays. Radiography using radium depends upon the emission of penetrating rays produced by the decomposition of radium or radium salts. Table 1 shows the various steps in the decomposition process.

Alpha and beta rays produced by the decomposition have no direct use in radiography, as their path is so short that it is doubtful if they ever leave the container in which the radium is placed. Even if they did penetrate this container they probably would not reach the casting being examined, let alone penetrate it.

Gamma-rays, on the other hand, have very short wave lengths, and hence high penetrating power. As previously described under x-rays, because of the short wave lengths involved radiographs made with gamma-rays have high latitude, and little or no difficulty will be experienced in showing defects in heavy and light sections radiographed on the same film.

Using the same reasoning, the contrast will be lower than that obtained with x-rays having greater wave lengths, thus making it somewhat more difficulty to distinguish defects recorded on the film than would be the case with the same defect located by x-rays. In this connection, Figs. 6 and 7 should be compared.

In the case of light metal castings and thin-walled castings having fairly uniform cross sections, the use of x-rays is preferred. Because of the bulkiness and weight of x-ray equipment, it usually is necessary to transport castings to a special area set aside for the purpose and where the

Fig. 9—X-ray head, 220 kvp. Transformer and tube are combined in head. Jib crane mounted.

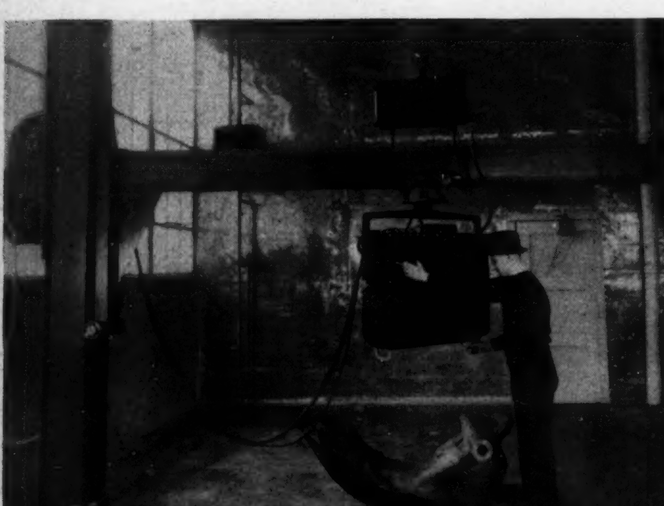
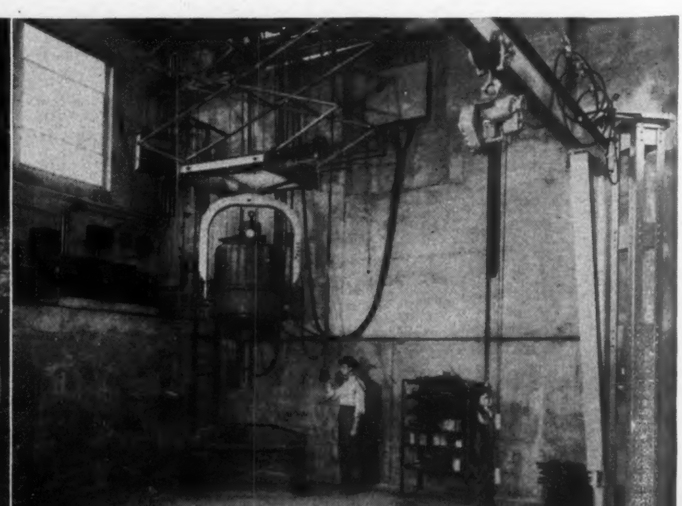


Fig. 10—X-ray head, 1000 kvp. Combined tube head and transformer. Pantograph mounted.



equipment has been permanently installed.

Figures 8, 9, and 10 show several x-ray installations, the control panels for each piece of equipment being placed in a separate room. For ease of transportation and setting up for radiographing, radium is much to be preferred, and in many places, such as those where no electrical power is available, it is the only equipment which can be used.

Even where a complete x-ray installation is available, radium is a necessity in certain locations in some castings, where openings are too small to insert a film or an x-ray tube. The radium itself (usually in the form of radium sulphate) is enclosed in a small, hermetically sealed silver capsule, which in turn is enclosed in an aluminum or steel "egg" from which the silver capsule is not removed during its use.

For safety to personnel during transportation from place to place, the radium container is placed in a carrying case provided with approximately 2 in. of protective lead on all sides.

One of the chief drawbacks to the use of radium is the long exposure time required as compared with x-rays. In many cases, convenience overbalances this deficiency. In other cases, several castings can be radiographed at the same time with the same unit of radium, which is not possible with most types of x-ray equipment.

Many of the larger castings cannot be x-rayed conveniently with anything less than 1000-kvp. equipment which, in addition to being expensive, is very bulky and requires a room with heavy walls to provide protection for operating personnel from the effects of the rays.

Where the production of a foundry is sufficient to cover the cost of high voltage x-ray equipment, its use is recommended because of its speed, especially in radiographing heavy sections, and because of its greater sensitivity. However, in most foundries the use of radium probably will continue.

Even the slow speed of gamma-radiography is not necessarily a handicap, as indicated in Fig. 11, which shows 22 valve bodies being radiographed at one time. With such a set-up it often is convenient to arrange a large number of castings in such a manner that the exposure will be continued overnight, when all personnel, including the radiographer, may be absent.

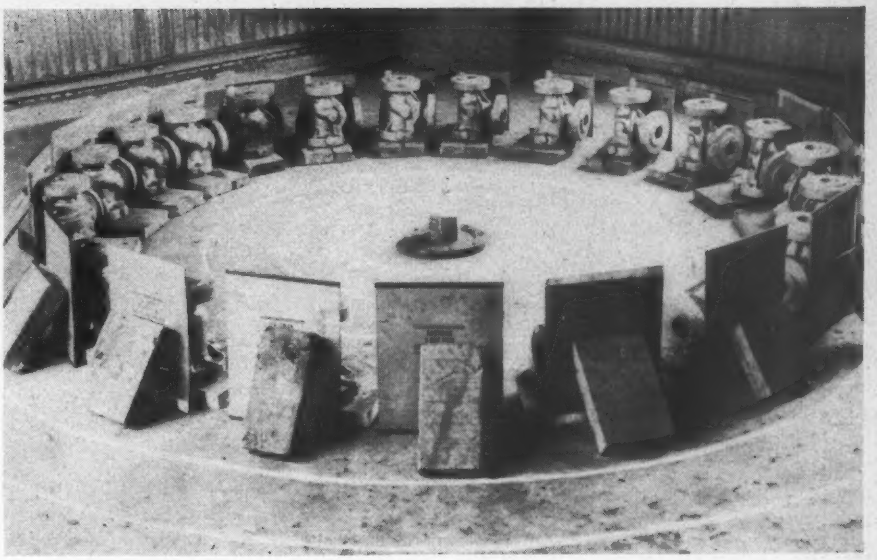


Fig. 11—Twenty-two valve bodies radiographed at one time. Circles painted on floor facilitate placing parts at correct distance from radium (center).

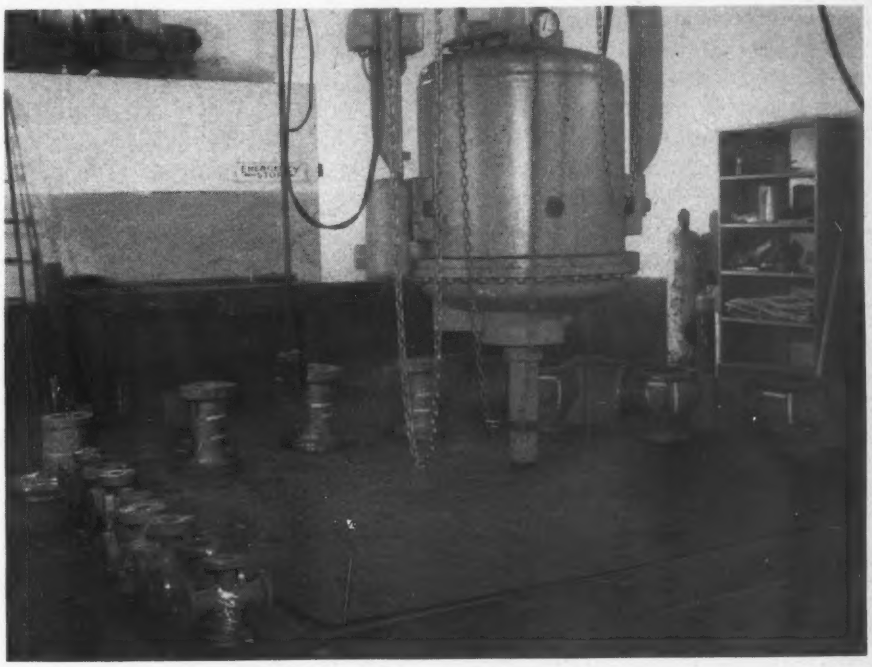


Fig. 12—Multiple set-up employing 1000 kvp. x-ray equipment.

It should be mentioned that such multiple setups are not limited entirely to gamma-radiography, as indicated by Fig. 12, where several castings are arranged around the target of a 1000-kvp. x-ray. At present such x-ray set-ups are limited almost entirely to equipment capable of operating at 1000 kv. or higher.

After several years' experience in radiographing steel castings of various sizes and shapes, the writers can say that gamma-radiography has served the trade well in insuring satisfactory castings, and probably will continue in use in most foundries, but they recommend the use of x-rays where practicable and economical.

Before leaving the subject of radiography, it would be well to mention some of its limitations. Although it is at present the only nondestructive method which will show with certainty the presence of deep-seated defects and reveal the types of de-

fects present and their extent, it does fail to show many small defects with certainty, especially closed cracks, often the most harmful defects in a dynamically stressed member.

With low-voltage x-rays in some instances it is possible to locate defects the smallest dimensions of which are 0.5 per cent of the section thickness. In most production inspection, 1 per cent is as much as can be expected, and when using gamma-rays, 2 per cent is about the best that can be obtained.

In some cases it may not be possible to find defects which are smaller than 3 to 6 per cent of the section thickness. Fine surface cracks are difficult and often impossible to locate, particularly in heavy sections and other parts of castings of designs which do not lend themselves to radiographic examination.

Magnetic Inspection. As previously stated, radiographic inspection often is unable to reveal fine cracks and other harmful defects of dimensions smaller than a certain percentage of the section thickness.

In other cases, defects occur in large castings in locations which are of such shape and size that it is impossible to place the film or the source of radiographic energy to obtain suitable rendition of the defect on the film. Furthermore, harmful defects sometimes occur in the most highly stressed sections of the casting which, however, may be too heavy for radiographing. Many of these castings are of such design that to date it has not been found possible to prevent the occurrence of cracks with assurance, yet these cracks are at times so fine or tight that they are difficult or impossible to find by visual inspection, radiography, or other means of nondestructive testing so far described.

General Characteristics

It is desirable, therefore, to have a method of inspection which will locate the presence of such defects. Magnetic inspection serves this purpose provided the part being tested is capable of being magnetized.

In general, the magnetic test consists of magnetizing the area to be tested and applying magnetic particles in the form of a powder, by dusting or spraying with an oil suspension of the particles. If the piece being tested contains no discontinuities, the magnetic lines of force will tend to folow a continuous path through the material.

If a defect or other metallic discontinuity is present, these lines are forced to find a path around the obstruction. If the discontinuity is at or near the surface, some of the lines of force will pass through the air and cause the magnetic particles to pile up, thus making the presence of the defect readily apparent by visual inspection.

Although a strong permanent magnet or an electromagnet may be used to magnetize the part under test, magnetization usually is more conveniently accomplished by passing an electric current directly through the piece. The current in its passage through the metal produces circular magnetic lines of force in a plane at right angles to the direction of current flow.

Test Methods

The most popular procedures for applying the current to the castings are the prod and the all-over methods. A third method, consisting of wrapping a conductor such as ordinary welding cable around the part in the fashion of a solenoid, usually is more convenient in testing finish machined parts where even slight arcing at contacts might burn the finish.

The prod method consists essentially of pressing two conductors, spaced approximately 6 to 8 in. apart, against the surface of the casting at the area being inspected, thus placing that part of the casting in series with the electric circuit.

While the current is being applied, magnetic particles (iron filings cloaked in colored powder) are dusted over the casting surface between the prods and the excess powder gently removed by blowing obliquely over the surface by lung power, or preferably by a controlled air blast such as may be obtained by using a 5/16-in. I.D. air or oxygen hose with the air throttled to about 2 psi. by means of an acetylene or other low-pressure regulator.

Magnetizing Equipment. The chief requirement for magnetic powder inspection is equipment which will supply current of sufficient amperage at as low voltage as practicable.

Welding generators, when used with certain precautions, will serve to produce the required current for magnetic powder inspection when using the prod method. When amperage in excess of the capacity of a single generator is required, machines may be connected in parallel.

Arcing

When using welding machines as the source of current, a contactor switch should be provided to break the circuit before removing the prods since, because of the comparatively high voltage involved, an excessive amount of arcing will occur if the circuit is broken by removing the prods.

Arcing may cause surface cracking and, in the case of higher carbon and alloy steels, will produce hard spots which will interfere with machining. Arcing should be avoided especially on finished machined surfaces.

Storage batteries provide a readily portable source of current. Each storage cell will supply approximately 300 amperes and, by connecting the cells in parallel, multiples of 300 amperes may be made available. The low voltage (2 volts) eliminates the danger of harmful arcing, and therefore the need for contactor switches.

When using storage batteries care should be taken that individual contact periods be made as short as practicable, consistent with efficient examination, in order to prevent excessive discharge of the cells. Because of the rapid discharge an ammeter should always be provided in the testing circuit to insure the necessary current density at all times.

Specially designed magnetic equipment is available which will provide a convenient means of obtaining any desired amperage for the prod method, all-over method, or the wrap-around method. Although convenient contactor switches are supplied the equipment is designed to work at low voltages, thus minimizing the dangers resulting from arcing.

The all-over method is similar to the prod method except that, instead of spacing the electrical contactors a short distance apart, contact is made to each end of the casting, or other extremities chosen to control the flow of the current and the direction of the magnetic flux. The whole casting between the contacts becomes magnetized.

With this greater distance it is

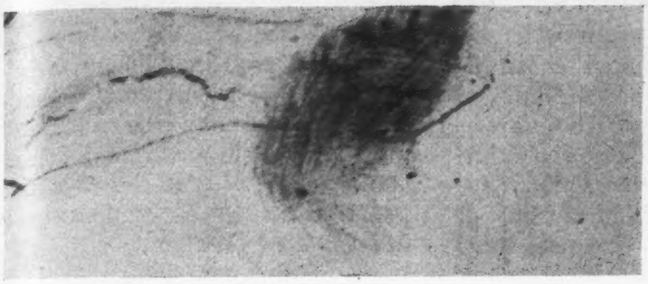


Fig. 13—Defect in bronze casting as seen by visual inspection.

Fig. 14—Same defect under black light after fluorescent oil treatment.

necessary to use higher currents, usually of several thousand amperes, depending upon the size and shape of the casting, to compensate for the greater spacing of the contacts. Magnetic particles are sprinkled over the whole casting surface and removed in the same manner as in the prod method.

In general, the all-over method is particularly applicable to large castings because of speed gained in its application, but is not as sensitive as the prod method by which better control of the magnetizing current may be obtained. The prod method usually is found more convenient and accurate for the inspection of smaller castings weighing under 500 lb.

Because of the possibility of using larger current concentrations, the prod method is more suitable than the all-over method for locating defects which lie slightly below the surface of the casting.

General Practice

Magnetic inspection is often limited to certain critical locations of castings. Care should be exercised in applying the magnetic particle test, as operators unfamiliar with the various types of defects and their location in the casting are likely to use the test indiscriminately, requiring the removal of metal under every indication, whether harmful or not.

It is not unusual to limit the use of the test to the detection of surface hot tears and cracks, other defects which are indicated by the test being dressed with a grinding wheel to determine the depth, often rechecking the ground area before chipping when this is found necessary.

A variation of the magnetic test consists of using magnetic particles covered with material which fluoresces under ultraviolet light. As the indications produced by the glowing particles are much more distinct than those resulting from ordinary particles, this method is especially useful in testing for defects in the bores of cylinders, inside of tubes and other locations where the lighting is such that the usual magnetic powder indications are difficult to distinguish.

Electrical Conductivity. This method is one of the simplest yet probably the least used of any nondestructive method known, and where applicable gives good results which are reproducible from casting to casting. It is practicable only where a large number of castings of the same design are made within close dimensional tolerances and rather close composition control.

Procedure

The method consists of passing an electric current through the piece, or selected areas on the piece, using constant voltage. The success of the test lies in the fact that, if all pieces are of the same size and contain no defects, the conductivity of each piece will permit the same amount of current to pass.

If a nonconducting defect exists in the casting, the actual conducting cross section is reduced and the resistance is increased proportionately. This increase in resistance permits a lesser amount of current to pass, which fact is determined by an ammeter in the testing circuit.

It is evident that this method is applicable only in cases where a large number of similar castings are to be inspected, and requires a number of parts which are known to be sound in order to standardize the equipment.

Penetrants. The writers have attempted to describe the fields of usefulness of radiographic and magnetic particle inspection, and to point out that the latter method is the only one on which reliance can be placed to show positively the presence of fine surface defects which cannot be located by visual inspection, radiography, or other known nondestructive tests.

Unfortunately, the magnetic particle method cannot be used with nonferrous or austenitic alloys, although some of the latter may be slightly magnetic because of a small amount of retained alpha iron, A test which will locate positively the presence of fine surface defects in nonmagnetic castings is desirable.

Oldest of such tests is the one commonly known as the "oil and whiting test," in which a thin oil is applied to the surface of the casting and allowed to remain in contact for a time sufficient for the oil to be absorbed into any openings by capillary attraction.

If all oil is then removed from the surface and the part allowed to stand for a time, a slight amount of the oil will seep from the openings and become visible on the surface. To expedite the process, the cleaned casting should be painted immediately with whitewash which, when allowed to dry thoroughly, not only tends to absorb the oil from the opening (thus hastening seepage), but also shows this seepage to advantage by the discoloration of the white surface.

Instead of using whitewash, powdered talc may be dusted over the surface. This is not as sensitive as a thin coating painted on, but the casting is easier to clean afterward.

A commercial process has been developed for the purpose, utilizing a highly penetrating oil in which is dissolved a substance highly fluorescent under ultraviolet light. After sufficient time has been allowed for complete penetration and the oil has been cleaned from the surface, a so-called dusting powder is dusted or poured over the surface.

This powder absorbs the oil from

the defect much as ink is absorbed by a blotter. The casting is examined under black light (an invisible form of ultraviolet light), and the oil absorbed on the surface by the powder fluoresces or glows, giving a strong indication of the underlying defect.

Figure 13 shows a tear in a bronze casting as seen by visual examination. Figure 14 shows the same defect treated with fluorescent penetrating oil and developing powder and viewed under black light.

Like magnetic inspection methods, this latter method using a fluorescent penetrating oil shows even the finest surface defect in great detail. However, unlike magnetic inspection methods it does not give indications of interior defects unless these actually reach the surface, in which case the indication is limited to the exposed part of the defect. For interior defects, even if close to the surface, it is necessary to use radiography or some other method of nondestructive testing.

Supersonics. The use of high frequency sound waves (pitch above the audible range) is at this writing the latest development in methods of nondestructive testing. If supersonic vibrations are set up at one end of an object, the wave travels to the opposite end of the piece and is reflected back to the point of origin, the time of travel being measured by an ocillograph.

Principle

If a discontinuity lies in the path of the wave, this path, and hence the time of traverse, is shortened, the wave being reflected from the defect. The wave automatically plotted on the ocillograph will indicate the location of the discontinuity and may indicate its approximate size.

Supersonics have been developed to the point where they have been used with considerable success in examining forgings, rolled plate and other simple shapes. Because of the usually intricate shapes of castings and the comparatively rough surfaces, and also because the most likely defects occur at locations of compound curvatures, it has not been found practicable to apply this method to casting inspection beyond a limited extent.

In the near future the process and equipment will doubtless be developed to the point where an additional and valuable nondestructive testing method will be available.

It has been the intention of the writers to cover briefly the different methods of nondestructive testing as applied to the inspection of castings, and to discuss the comparative advantages and disadvantages of each.

Test Value

The value of any test depends upon the ability of the inspector, and this probably applies especially to those who have the obligation to accept or reject castings because of the results of nondestructive tests. The writers have seen cases where serviceable castings have been scrapped, and also where castings have been accepted only to fail later in service.

An inspector who has not had an exhaustive training and been able to prove his ability to interpret the results of tests correctly should not be permitted to pass final judgment upon the acceptability of a casting. Cases may be mentioned where newly hired personnel without manufacturing experience has been placed in inspection departments and, after a few hours' instruction, permitted to reject parts with finality.

It is the writers' opinion that a person cannot be a successful inspector until he has had thorough training in manufacturing processes as well as in the technique of inspection methods and the interpretation of tests.

Regardless of the inspector's ability in interpretation, he cannot do a satisfactory job of inspection unless he has been given standards of acceptance to which he can work and which will aid his judgment in making decisions. It is not to be expected that the inspector will do his work with constant reference to the standards.

Acceptability

Unless the foundry technique is poor or entirely lacking, no question will arise concerning the acceptability of good castings, and the same applies to those which are rejectable without question. Only in borderline cases will it be necessary to refer to the standards.

As further interpretation experience is gained, the standards will become more and more like a fire insurance policy, the cost of which is paid willingly with the hope that it never has to be used.

It is believed that the more important nondestructive test methods which are currently being used and are applicable to the examination of castings have been discussed in this paper. Detailed descriptions have been omitted as separate articles in the literature describing details of technique and the necessary equipment are available.

It must be borne in mind that, although an excellent job of inspection can be accomplished by the use of these methods, no method yet developed is sufficient in itself to determine with finality the presence and extent of all types of defects.

Tests for Defects

Rather, each method has its own advantages for certain types and locations of defects, and each method usually serves best when used in conjunction with one or more of the other tests. Constant development is underway with most of the methods to make them more sensitive, enlarge their field and shorten the time necessary for inspection.

Foundry Use of Nondestructive Inspection. Visual inspection is probably used in all foundries. However, it has been the experience of the writers that many castings with small surface blemishes, which would in no way affect the serviceability, have been rejected because visual inspection failed to give any indication as to whether the discontinuity on the surface extended into the body of the casting.

This has been the case especially with pressure castings and with structural castings which might be subjected to severe loading and reversed stresses in service where an internal defect would be liable to progression as a result of these stresses. In such cases it becomes evident that a test which would give proof of internal soundness would introduce considerable savings in the foundry.

In spite of this possibility, many foundries have shown hesitancy in accepting these new methods of inspection, probably fearing that any method which would indicate the presence of defects not found by previously known methods could not fail to increase the percentage of rejected castings.

It is true that this has happened in a number of cases when radiog-

raphy and magnetic inspection were first used, as these methods began to show up defects of which the particular foundries were unaware.

However, when these same foundries began using the results of this inspection to determine the exact location of defective areas, then changing the foundry technique to eliminate these defective areas, it was found that most of the castings could be made without harmful defects. Also, by knowing the exact extent of all internal defects it became a simple matter to suggest design changes which would reduce the liability to unsoundness.

Use of radiography, for instance, has almost eliminated the necessity for sectioning or breaking castings to determine soundness. One steel foundry reported that the cost of castings which would have been cut up for inspection, had radiography not been available, had paid the cost of all radiographic inspection in that foundry, including the cost of equipment, materials and personnel.

It is probable that other foundries also have found this to be true. It is the writers' opinion that with the adoption of practical nondestructive testing methods and with a sincere effort to improve the quality of the castings, foundrymen will find that sound castings can be produced economically and the use of nondestructive testing a distinct asset instead of the liability which many have considered it.

Acknowledgment

Grateful acknowledgment is made to the Boston Naval Shipyard; the New York Naval Shipyard; the Naval Research Laboratory; Bath Iron Works Corp., and General Electric X-ray Corp. for the photographs and radiographs used in this paper.

CHICAGO CHAPTER
Active In City Production Conference

Holding more meetings than any other participating group, the Chicago A.F.A. chapter sponsored six technical sessions at the Chicago Production Show and Conference held in the Stevens Hotel, March 20, 21 and 22.

One of 47 member organizations of the Chicago Technical Societies Council, the chapter aided in promoting this conference by arranging 15 informative technical talks.

General chairman for the A.F.A. sessions at the production conference was Oscar Blohm, chief metallurgist, Foundry Division, Hills-McCanna Co., Chicago. Aiding him as vice-chairman and honorary chairman, respectively, were Bruce L. Simpson, president, National Engineering Co., Chicago, and E. R. Young, district manager, Climax Molybdenum Co., Chicago.

Modern Techniques Described

The first session was addressed by James L. Yates, construction engineer, Worthington Pump & Machinery Co., Buffalo, N. Y. Mr. Yates' talk on plant engineering and foundry operations was followed by a paper dealing with foundry modernization presented by Lester B. Knight, Lester B. Knight & Associates, Chicago. Chairman of this session was R. L. McIlwaine, vice-president, National Engineering Co.

In a session dealing with pattern design and interchangeability, and permanent mold production, talks were given by William E. Tharp, foundry technical supervisor, Caterpillar Tractor Co., Peoria, Ill., and Maj. Jack W. Wheeler, consultant on permanent molding, Springfield, Mass. The meeting was conducted by Co-Chairmen Harry J. Jacobson, Industrial Pattern Works, Chicago; and John Mader, Stewart Die Casting Corp., Chicago.

W. D. McMillan, works metallurgist, International Harvester Co., Chicago, was chairman of the third foundry session. Duplexing of malleable iron was discussed by W. R. Jaeschke, foundry engineer, Whiting Corp., Harvey, Ill. James E. Kearney, chief engineer, Swenson Evaporator Co., Harvey, Ill., talked on uses for cast iron in the chemical industry.

Foundrymen attending the session on magnesium heard five papers. Addressing the meeting were the following of Dow Chemical Co., Midland, Mich.: M. V. Chamberlin, who presented a paper co-authored by J. G. Mezoff on magnesium foundry practice; C. E. Nelson, who read a paper on casting design by Dr. G. H. Found, design engineer; and A. T. Peters, who talked on pumping magnesium. Marvin E. Gantz, metallurgist, American Magnesium Corp., Cleveland, described the use of calcium in magnesium alloys. Micro-porosity in magnesium alloy castings (printed in full elsewhere in this issue) was presented by J. A. Davis who wrote the paper in collaboration with L. W. Eastwood, also of Battelle Memorial Institute, Columbus, Ohio.

The steel session was under the chairmanship of L. H. Hahn, metallurgist, Sivyer Steel Casting Co., Chicago. C. E. Sims, Battelle Memorial Institute, discussed behavior of certain cast steels at low temperatures. G. A. Lillieqvist, director of research, American Steel Foundries, East Chicago, Ind., reviewed recent metallurgical developments in steel casting production.

A final session dealt with brass and bronze. A. W. Gregg, foundry engineer, Whiting Corp., Harvey, Ill., presided. Experiences in war-torn Europe were related by Carl O. Thieme, vice-president and works manager, H. Kramer & Co., Chicago. Walter W. Edens, technical director, Ampco Metal, Inc., Milwaukee, explained the use of bronze as an engineering material.

Refractories Committee Plans Convention Panel

Led by a group of outstanding and qualified leaders, a panel discussion will take up current foundry refractory problems at the forthcoming 50th Anniversary meeting in Cleveland.

Headed by Charles S. Reed, Chicago Retort & Fire Brick Co., Chicago, as moderator, the panel membership will include: R. H. Stone, Vesuvius Crucible Co., Swissvale, Pa.; J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.; A. S. Klopf, Lester B. Knight & Associates, Chicago; and E. J. Carmody, Charles C. Kawin Co., Chicago.

For the presentation and discussion of more formal papers, a second session on refractories will be held, to consider such aspects as: practical application of foundry refractories; rammed linings in electric steel foundries; and, how to line up and keep in repair a new cupola.

CAST IRON . . .

Modulus of Elasticity

Technique usually employed in making transverse tests does not involve the precise measurements required for a cast iron modulus determination of practical value. Further fundamental work should ultimately provide a true conception of cast iron and its use to best advantage.

Alvin J. Herzig
Metallurgical Engineer
Climax Molybdenum Co.
Detroit

THE DESIGN of useful articles from the materials of trade is made easier when we assign to these materials, as a constant property, a value for the modulus of elasticity. Such an assignment is based on two premises, both of which are merely convenient approximations. These premises are, that our engineering alloys are homogeneous and that homogeneous metals and alloys obey Hooke's Law.

In the first place, the materials with which we deal are never homogeneous; and in the second place, even homogeneous materials should not be expected to exhibit a linear stress-strain relationship. Analysis of the attractive and repulsive forces between atoms provides no basis for such a simplification in the relationship between stress and strain. It is doubtful whether a metal ever obeys Hooke's Law, since greater refinement of measurement indicates greater divergence from it.

Provision for Strain

Nevertheless, engineers have long recognized that the accommodation of stress in any material involves strain and that the design of a useful machine element which is to carry a stress implies that the accompanying strain be provided for.

The significance of practically immeasurable strain in problems of design is not so great, nor is our ability in construction to provide for very small deformations so fully developed, but that the stress-strain relationship in many metals and alloys may be regarded as a straight line at low loads. For example, in steel substantially all of our design problems involving elasticity may be safely approached on the assumption that the modulus of elasticity is constant between zero load and the elastic limit.

However, when we are concerned with alloys which are manifestly heterogeneous (such as cast iron), or when even in homogeneous materials we are investigating problems which involve the theory of elasticity, we should recognize that our present conception of the modulus of elasticity is empirical. No one believes that the usual laboratory tensile test measures, even relatively, atomic cohesion. No one should assume that our present methods of computing a value for modulus give us, even relatively, a measure of the elasticity of the atomic bond.

Stress-strain Relationship

In cast iron the stress-strain relationship is complicated by the additional circumstances that even under very low loads, the deformation of cast iron is only partly elastic. The usual routine methods of measuring that deflection of cast iron bars under transverse loading are sufficiently accurate to reveal a continuous curvature in the stress-strain relationship, and obviously there is no basis for assuming a constant modulus of elasticity in any range of stress. Furthermore, unlike steel, cast irons of different types have widely different values for modulus.

Some investigators have approached the study of modulus of elasticity in cast iron from a fundamental point of view. Extension of this type of work will ultimately give us a true conception of what cast iron is, how it behaves, and how to use it to best advantage. At present we are concerned with the more immediate demand for useful engineering information.

Granting that it is evident that Young's modulus of elasticity must be an empirical figure for cast iron, since no part of the stress-strain curve is a straight line, relative values for the stiffness of iron are still required. Dr. MacKenzie pointed out in 1933 that it was apparent from transverse bending curves that the modulus of elasticity would vary from point to point on the curve, but that when the modulus was calculated from the actual deflection at stresses comparable to those contemplated in the design, the resultant modulus might be used confidently for calculating the bend of the member.

Because we have had in the past a free choice to adopt any type of test, and because we have had an unexplainable urge to report a high value rather than a reliable one, we have recorded values for modulus of cast iron up to 40 million psi. Most of the available values for the modulus of elasticity of cast iron have been calculated from transverse test data.

The technique usually employed in making the transverse test does not involve the precision measurements required for a modulus determination of practical value. If all the data which can be put on a comparable basis are examined, the

spread is alarming, especially if we regard the whole range of cast irons as a single type of material. While this may be permissible for alloys which are pseudo-homogeneous, such as steel, it cannot be admitted in the case of cast iron.

Metallurgists as a group accept the proposition that the properties of cast iron are dependent to an important degree upon the amount, size, shape, and distribution of the graphite. As early as 1929 it was shown that the stress-strain relationship of cast iron could be simulated in steel by making slits, holes, and notches in steel test bars, thus imitating the effect of graphite in cast iron on the section modulus. In 1937 Bolton published a chart correlating the elastic modulus determined in tension with the graphite content of cast iron.

For the purpose of this discussion, it seemed advisable to extend the correlation begun by Mr. Bolton; but because the data on stress-strain curves from the transverse bend tests are more numerous, it was decided to base this extension on transverse test data rather than on moduli determined in tension.

In all, 108 stress-strain curves were found which could be regarded as reliable for irons on which the graphitic carbon content was reported. A wide variety of irons was represented. Some of the transverse tests were made on 2-in. bars, on 24-in. centers; and some of the tests were made on 1.2-in. bars, on 18-in. centers.

The relative elastic modulus was calculated from these data when such computation had not already been made at the source of the information. For the 1.2-in. bar, the formula $E = 1194 \times P/D$ was used, and for the 2-in. bar, $E = 367 \times P/D$, where P was taken as 25 per cent of the ultimate load and D was the deflection at load P in inches, as described in the 1933 A.F.A.-A.S.T.M. *Symposium on Cast Iron.* Moduli thus obtained were plotted against graphitic carbon content of the irons, as shown in the graph.

It is not unfair to expect that in the manipulations of the transverse test errors aggregating ± 10 per cent are obtained. The shaded area shown in the figure represents such an error band. This band includes 70 per cent of the results, and it is believed that the other 30 per cent could be accounted for if it were possible to take into consideration not only the amount of the graphite, but the size, shape, and distribution of the graphite flakes as well.

At this time it may be concluded that the divergence between the elastic modulus of cast iron and that of steel, and the scatter in values for cast iron, are entirely a function of the graphite carbon which the cast iron contains.

Until fundamental work provides more knowledge of the elastic behavior of cast iron, it would seem wise to adhere to the practice of calculating a relative modulus of elasticity from a carefully conducted transverse test with all its present empirical assumptions. A tendency to determine values for modulus of elasticity of cast iron by other methods has already led to the unfortunate and erroneous conclusion that some fundamental concepts of mechanics and metallurgy do not apply to all types of cast iron.

Acknowledgment

The original data used in this report were obtained on bars produced at: American Cast Iron Pipe Co., Allis Chalmers Manufacturing Co., Campbell, Wyant & Cannon Foundry Co., Climax Molybdenum Co., Gardner-Denver Co., Lakey Machine & Foundry Co., and National Supply Co.

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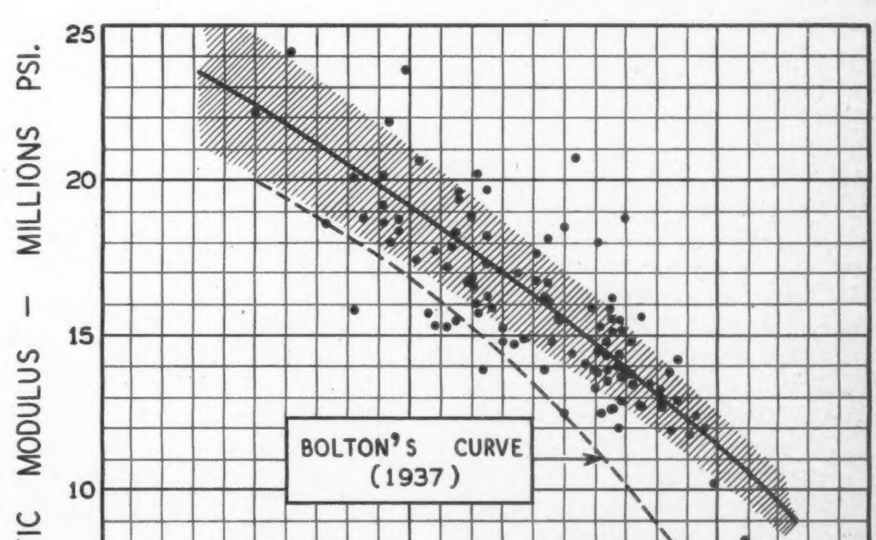


PRICE PER POUND
PRICE PER PIECE
Which?

Ralph L. Lee
Comptroller
Grede Foundries, Inc.
Milwaukee

HOW SHOULD THE FOUNDRY sell its castings—on the *price per piece* or *price per pound* basis? A controversy has existed over this question for many years. Some foundrymen believe that it makes little difference to them, or to their companies, how their product is sold. Does it really matter?

The writer believes that it does matter—there is a substantial difference. In the writer's opinion, after being associated for many years with a company which sold its product on a price per piece basis, he feels that the advantages of the price per piece policy, both to the producer and to the consumer, are great enough to eliminate the price per pound policy from further consideration.

The writer also believes that to secure maximum benefits from the price per piece sales policy, operations in the producing foundry should be on a piecework basis wherever possible. Piecework rates should apply especially in the core, molding, and cleaning departments.

To bring out the point that the price per piece basis is more equitable than the price per pound, the writer presents his cost methods with examples based on logical and basically sound assumptions. In the examples cited, the cost items, e.g., the metal, core, and molding costs and burdens, are not actual figures. It is assumed that the foundry has piecework systems in its core, molding, and cleaning departments. If, as is the case with many foundries, cleaning is done on a pound basis, the price differential for weight variation, in the gray iron example, should be seven cents per pound instead of two cents per pound.

Also, the figure used for cleaning cost includes the burden. Various foundries figure cleaning burden in so many different ways that any percentage burden given would lead only to controversy as to how it had been calculated.

Table 1*

PER PIECE VS. PER POUND
(10-LB. GRAY IRON CASTING)

Core Cost	Direct	$0.10
	Burden (200%)	0.20
Mold Cost	Direct	0.20
	Burden (200%)	0.40
Cleaning Cost		0.50
		$1.40
Metal Cost at $0.02/lb.		.20
Total Cost—	Per Piece	$1.60
	Per Pound	0.16

*To avoid controversy, no profit is added. If it were, the results would be approximately the same.

Table 1 presents data that would normally appear on an estimate sheet in relation to the core, mold and cleaning costs of a 10 pound gray iron casting.

If the actual weight of a casting is always the same as the estimated weight, there is no difference between per pound and per piece selling prices. But (and it's a big one), how many foundrymen can "guesstimate" the exact weight of a casting consistently?

The weight of the previously mentioned gray iron casting was estimated at 10 pounds. Table 2 shows what happens when there is a plus or minus variation from the 10 pound estimated weight.

Under the price per piece sales policy, the price of each casting would be as shown in Table 2. This is because the sales agreement with the customer would be that for any variation in weight from the estimate, he would be charged, or credited, for the cost of the metal in the casting, over or under the

Table 2

CASTING COSTS WITH WEIGHT VARIATIONS

		Lower		*Estimated Weight*	Higher	
Casting Weight, lb.		8	9	10	11	12
Core Cost	Direct	$0.10	$0.10	$0.10	$0.10	$0.10
	Burden	0.20	0.20	0.20	0.20	0.20
Mold Cost	Direct	0.20	0.20	0.20	0.20	0.20
	Burden	0.40	0.40	0.40	0.40	0.40
Cleaning Cost		0.50	0.50	0.50	0.50	0.50
Piece Cost		$1.40	$1.40	$1.40	$1.40	$1.40
Metal Cost @ $0.02/lb.		0.16	0.18	0.20	0.22	0.24
Total Piece Cost		$1.56	$1.58	$1.60	$1.62	$1.64

estimated weight at two cents per pound.

Now what happens when the castings are sold on a price per pound basis? The agreement with the customer would be that he would be charged or credited for any weight variation of price on the price per pound basis. Therefore, any weight variation would have to be compensated for on a price per pound basis, or 16 cents per pound.

On which basis would you, as a producer, rather make a price adjustment to your customer, at two cents per pound or at 16 cents per pound? The writer does not hesitate to state that the two cents per pound is the correct basis of customer compensation because it represents the actual cost of the metal weight difference between the estimated and actual weight of the casting.

Irrespective of casting weight, the core and mold must be made according to the dimensions of the drawing. Their size, and the equipment used to make them, is dependent upon the dimensional specifications of the drawing as reflected in the pattern and core box equipment. Therefore, the cost of these operations can be calculated accurately. Likewise the cleaning cost can be estimated accurately from time-studies and price-rates on similar castings. Metal cost per pound is known from the day to day melting operation. The major difficulty is in the estimation of the metal volume in the proposed casting and, therefore, weight.

Volume Calculation

When the price per piece policy is used, the producer admits the possibility of an error in his casting volume calculation and takes steps to allow for the error. When the price per pound policy is used, the producer indirectly infers that he has no confidence in his estimates on core, molding, cleaning and metal costs because he distributes his weight error over all those operations. He is placing part of the cost of each operation in the price per pound and not correcting for metal weight only. He penalizes all departments for an error which actually affects only one, the melting department.

Let us compare the results of the per piece price vs. the per pound price quotation, and its effect when the actual weight of a casting varies from the estimated weight.

Price Fluctuation

Table 3 shows the effect of a one and a two pound weight variation over and under the estimated weight. The second line in Table 3 shows the actual piece cost of the casting, as shown in Table 2, and the third line the sale price of the castings with a price per piece policy. The fourth line shows the price of the casting when the customer is charged on a per pound basis and is obtained simply by multiplying the weight by 16 cents per pound, the quoted per pound price.

The next line shows the loss or gain to the foundry quoting on a price per pound basis as against the actual casting cost. This shows that on a per pound basis, the foundry would lose 28 cents on each casting it sold if the casting actually weighed two pounds less than the estimated weight. The last line is self-explanatory.

Table 4 shows the price paid by the consumer on orders of 100, 500 and 1000 castings on both the per piece and per pound basis, while Table 5 shows the loss or gain to

Table 3

EFFECT OF PER PIECE VS. PER POUND PRICE ON CUSTOMER CHARGES

	Under		*Estimated Weight*	*Over*	
Casting Weight, lb.	8	9	10	11	12
Total Piece Cost	$1.56	$1.58	$1.60	$1.62	$1.64
Per Piece Price to Customer	1.56	1.58	1.60	1.62	1.64
Lb. Price to Customer	1.28	1.44	1.60	1.76	1.92
Gain or Loss to Foundry quoting on lb. Basis	—0.28	—0.14	0.00	+0.14	+0.28
Gain or Loss if Cleaning is on lb. Basis	—0.18	—0.09	0.00	+0.09	+0.18

Table 4

CONSUMER COST OF VARYING CASTING ORDERS

Casting Weight, lb.	*100*		*500*		*1000*	
	Piece Price	*Pound Price*	*Piece Price*	*Pound Price*	*Piece Price*	*Pound Price*
8	$156	$128	$780	$640	$1,560	$1,280
9	158	144	780	720	1,580	1,440
11	162	176	810	880	1,620	1,760
12	164	192	820	960	1,640	1,920

Table 5

EFFECT OF PER PIECE VS. PER POUND PRICE ON CASTING ORDERS

			Castings Ordered					
			100		*500*		*1000*	
Casting Weight, lb.	*Total Piece Cost*	*Cost per Piece, lb. Basis at 16c*	*Producer's Loss*	*Producer's Gain*	*Producer's Loss*	*Producer's Gain*	*Producer's Loss*	*Producer's Gain*
8	$1.56	$1.28	$28.00	....	$140.00	....	$280.00	....
9	1.58	1.44	14.00	....	70.00	....	140.00	....
11	1.62	1.76	....	14.00	....	70.00	....	140.00
12	1.64	1.92	....	28.00	....	140.00	....	280.00

Table 6

EFFECT OF INCREASED METAL COST

	Estimate				
Casting Weight, lb.	8	9	10	11	12
Cost up to Metal	$1.40	$ 1.40	$ 1.40	$ 1.40	$ 1.40
Metal @ $1.00/lb.	8.00	9.00	10.00	11.00	12.00
Cost and Sale Price under Per Piece Price Policy	$9.40	$10.40	$11.40	$12.40	$13.40
Sale Price @ $1.14/lb.	9.12	10.26	11.40	12.54	13.68
Gain or Loss on lb. Basis	—0.28	—0.14	0.00	+0.14	+0.28
Gain or Loss on lb. Basis, if Cleaning is on lb. Basis	—0.18	—0.09	0.00	+0.09	+0.18

the producer when the actual casting weight varies from the estimated weight.

The above figures show that if, under the per pound price basis, the producer underestimates the weight of the casting, he stands a loss. If he overestimates the weight, he makes a large profit and penalizes or alienates the customer. When selling on the price per piece basis he eliminates such risks.

Effect of Metal Cost

The author has spoken on "Costs" at a number of A.F.A. chapter meetings. Invariably, when such an example as has been cited is given, the question is raised, "That's all right for gray iron, but we run a brass shop and our average metal cost is 30 cents per pound," or "40 cents per pound."

Many foundrymen believe that a higher metal cost will transform losses to profits. What does higher metal cost do? It does nothing. It has no effect on the final profit or loss when a quotation is made on either the piece or the per pound basis.

Table 6 illustrates the results of increasing the metal cost to $1.00 per pound and assuming that the core, mold and cleaning costs remain constant.

The above figures answer the question "How much difference does metal cost make when quoting on a price per piece or price per pound basis?" The answer is, none. The gains and losses of the price per pound basis remain the same. If the metal costs $100 per pound it still would make no difference. Figure it for yourself.

Caterpillar Holds Supervisor Conferences

CATERPILLAR TRACTOR CO., Peoria, Ill., is sponsoring for its fourth year, their supervisor conferences. These conferences are offered on a voluntary participation basis and are open to all Caterpillar supervisors who desire to attend.

Whereas, in the past, emphasis has centered on mechanical problems, conferences added to this year's program pertain to effective speaking, practical psychology, leadership and reports for cost control.

JOINT SOCIETIES

Education Men Draft Foundry Course

HOLDING ITS FIRST MEETING at the Hotel Cleveland, Cleveland, recently, the Sub-Committee on Special Foundry Curriculum for Engineering Schools or Colleges, Joint Foundry Industry Committee on Education, drew up a tentative proposed curriculum for a special engineering-management college course. Arrangements were made for contacting a number of engineering schools concerning preliminary discussions leading toward final recommendation of a course that would be feasible from the standpoint of the schools and the industry.

Members present at the meeting were: F. G. Sefing, International Nickel Co., New York City, representing the A.F.A.; A. C. Denison, Fulton Foundry & Machine Co., Inc., Cleveland, and J. M. Price, Ferro Machine & Foundry Co., Cleveland, representing the Gray Iron Founders' Society; R. W. Crannell, Lehigh Foundries, Inc., Eaton, Pa.; and S. C. Wasson, National Malleable & Steel Castings Co., Cicero, Ill., representing the Malleable Founders' Society; and R. L. Collier, Executive Secretary, Steel Founders' Society of America, Cleveland, as representative of the S.F.S.A.

In an election of officers for the sub-committee, Mr. Price was elected chairman and Mr. Collier, secretary.

In the discussion it was agreed that the special foundry curriculum would best be constructed so as to fit into a regular four-year engineering course as given by most universities. It was thought that a minimum of departure from existing engineering curricula would make the project more feasible from the standpoint of the schools.

In regard to engineering courses in general, the committee brought out that as currently conducted, too much emphasis is placed on processes for obtaining metals from their ores; and, in the case of metallurgy, machine design and strength of materials, a disproportionate amount of work is devoted to rolled steel. Instruction relating to foundries, and their products, in proper relation to their industrial importance, should be introduced in schools where the course is established, members agreed.

In preparing the tentative curriculum, the committee recognized that, should it not prove possible to incorporate all the subjects into a regular four-year engineering course, consideration would be given to one or two years of post-graduate work for completion of specialized instruction.

In this latter regard it was decided that in preliminary discussions the schools should be asked to prepare and submit complete, balanced curricula including post-graduate subjects might prove necessary.

Proposed Curriculum

The suggested curriculum is intended to supplement a general engineering course including the usual subjects of 2 or 3 years of mathematics; physics; chemistry; mechanics and related work. The special subjects which follow would be dove-tailed into such a regular course largely in place of the electives which are usually provided for in the regular curriculum.

1. Foundry Metallurgy (2 semesters, 3 hours per week, recommended)
   - (a) Physical Metallurgy of Iron and Steel (Solidification of Metals, etc.)
   - (b) Metallography of Iron and Steel Castings
   - (c) Welding of Iron and Steel Castings
   - (d) Laboratory: Melting, Testing, etc.
2. Foundry Technology (2 semesters, 3 hours per week, recommended)
   - (a) Foundry Processes and Procedures
   - (b) Sands and Binders
   - (c) Refractories
   - (d) Laboratory: Molding, Coremaking, etc.
3. Personnel Management
   - (a) Employment Procedures
   - (b) Incentive Plans
   - (c) Time and Motion Study Technique
   - (d) Job Evaluation Technique
   - (e) Merit Rating Procedures
   - (f) Foreman Education
   - (g) Safety and Hygiene
   - (h) Methods Engineering
4. Economics
5. English (with all possible emphasis on Engineering Report Writing)

Classified Program 50th Anniversary Convention
(By Subjects and Divisional Interests)

Aluminum and Magnesium

Monday, May 6

12:00 PM—Round Table (Luncheon).
4:00 PM—Lecture Course, Foundry Control.
8:00 PM—Sand Shop Course, Magnesium Molding Sands.
8:00 PM—Technical Session.

Tuesday, May 7

10:00 AM—Technical Session.
4:00 PM—Technical Session.

Brass and Bronze

Wednesday, May 8

10:00 AM—Technical Session.
12:00 PM—Round Table (Luncheon).
4:00 PM—Sand Shop Course, Brass and Bronze Sand Control.
4:00 PM—Lecture Course, Foundry Control.

Thursday, May 9

2:00 PM—Technical Session.

Friday, May 10

2:00 PM—Technical Session.

Canadian Meeting

Tuesday, May 7

12:00 PM—Canadian Members' Luncheon.

Chapter Officers Meeting

Tuesday, May 7

7:00 PM—Chapter Officers' and Directors' Dinner.

Costs

Thursday, May 9

4:00 PM—Foundry Costs.

Gray Iron

Monday, May 6

4:00 PM—Shop Course, Cupola Mixes.

Tuesday, May 7

4:00 PM—Shop Course, Casting Defects.

Wednesday, May 8

10:00 AM—Symposium, Engineering Properties of Gray Iron.
2:00 PM—Shop Course, Casting Defects.

Thursday, May 9

8:30 AM—Shop Course, Carbon Control in Cupola.
2:00 PM—Technical Session.
8:00 PM—Sand Shop Course, Gray Iron Sand Control.

Friday, May 10

10:00 AM—Technical Session.
2:00 PM—Technical Session, Welding Gray Iron.
4:00 PM—Lecture Course, Foundry Control.

Inspection

Tuesday, May 7

10:00 AM—Technical Session.
8:00 PM—Technical Session.

Job Evaluation and Time Study

Thursday, May 9

2:00 PM—Job Evaluation and Time Study Discussion.
8:00 PM—Panel Discussion.

Malleable

Monday, May 6

10:00 AM—Technical Session.

Tuesday, May 7

2:00 PM—Technical Session.
4:00 PM—Lecture Course, Foundry Control.
8:00 PM—Sand Shop Course, Malleable Sands.

Wednesday, May 8

10:00 AM—Technical Session.
12:00 PM—Round Table (Luncheon).

Patternmaking

Thursday, May 9

2:00 PM—Technical Session.

Plant Equipment and Hygiene

Monday, May 6

2:00 PM—Joint Technical Session.
8:00 PM—Joint Technical Session.

Refractories

Tuesday, May 7

2:00 PM—Technical Session.
8:00 PM—Panel Discussion.

Sand Practice and Research

Monday, May 6

8:00—Sand Shop Course, Magnesium Molding Sands.

Tuesday, May 7

8:00 PM—Sand Shop Course, Malleable Sand Control.

Wednesday, May 8

10:00 AM—Technical Session.
2:00 PM—Technical Session.
4:00 PM—Sand Shop Course, Brass and Bronze Sand Control.

Thursday, May 9

8:00 PM—Sand Shop Course, Gray Iron Sand Control.

Friday, May 10

9:30 AM—Sand Shop Course, Steel Sand Control.

Steel

Wednesday, May 8

2:00 PM—Technical Session.

Thursday, May 9

12:00 PM—Round Table (Luncheon).
4:00 PM—Lecture Course, Foundry Control.

Friday, May 10

9:30 AM—Sand Shop Course, Steel Sand Control.
10:00 AM—Technical Session.
2:00 PM—Technical Session.

Training and Education

Tuesday, May 7

12:00 PM—Luncheon, Engineering School Alumni Groups.

Wednesday, May 8

6:00 PM—Foundry Instructors' Dinner.
8:00 PM—Foreman Training.
8:00 PM—Engineering Student Training.

Thursday, May 9

4:00 PM—Apprentice Training.
6:45 PM—Apprentice Training Dinner.
8:00 PM—Apprentice Training.

See pages 70-80 for Day-by-Day Program

Arrangements Completed For Local Plant Visits

The Plant Visitation Committee of the Northeastern Ohio Chapter has prepared a list of Cleveland plants willing to receive visitors during Convention Week. Under the Chairmanship of John Price of Ferro Machine & Foundry Co., many of the outstanding local foundry plants have been contacted and a partial list of plants available for visits is as follows:

Non-Ferrous

Wellman Bronze & Aluminum Co.
John Harsch Bronze & Foundry Co.

Pattern Shops

Motor Pattern Co.
Master Pattern Co.
Wellman Bronze & Aluminum Co.

Malleable

Lake City Malleable Co., Cleveland and Ashtabula Plants.

Steel

West Steel Castings Co.
Crucible Steel Casting Co.

Gray Iron

Fulton Foundry & Machine Co.
Bowler Foundry Co.

Light Iron

Taylor-Boggis Foundry Co.
Allyne-Ryan Foundry Co.
Ferro Machine & Foundry Co.
Ohio Foundry Co.
Superior Foundry Co.
Republic Steel Corp.—Strip Mill and Blast Furnaces.

It is expected that a large number of those attending the 50th Anniversary Convention will take advantage of the opportunity afforded them by the host plants. Complete details will be available at Convention time.

The Plant Visitation Committee will be represented by a booth in the Auditorium and arrangements for plant visits should be made with the committee on arrival. Unless special arrangements are made, visitors will be expected to provide their own transportation to and from the local plants they visit.

50 YEARS OF PROGRESS IN FOUNDRY

APPRENTICE TRAINING

J. E. Goss
Industrial Activities Administrator
Brown & Sharpe Mfg. Corp.
Providence, R.I.

APPRENTICESHIP IN the foundry dates back to the days when little, if any, thought was given to the applicant other than whether he was physically able to do the work. Those were the days when boys quit school at an earlier age than they do at present, and when it was much more likely for a boy to choose the trade of his father for his own life work.

The old apprenticeship agreements called for no education outside the foundry, excepting the learning of the catechism and regular attendance at Sunday School. In many cases, however, the apprentice was domiciled with the master and so, no doubt, learned much about foundry practice from the conversations that took place in the home after work hours.

In those early years boys were not as discriminating as they are today. A trade was a trade, whether it was in a foundry or in some other type of production. Moreover, comparatively little thought probably was given, when the boy entered apprenticeship, to any possibility other than that of becoming (and remaining) a satisfactory journeyman.

Early Foremen Self-Made

Foundry superintendents and foremen were men who themselves had learned the foundry trades through apprenticeship and who had developed certain leadership qualities during their years as workmen. Labor relations, human engineering, safety laws, workmen's compensation insurance, foremanship training and the like had not become factors in foundry operation.

Job analysis was unknown to the foundrymen of fifty years ago. If such a term had been used it probably would have been scoffed at as a fad having no place in such a practical business as making castings.

Partly because of this, the foundry apprentice of the early days was not taught the trade in as efficient a manner as is possible with an application of the now accepted practice of breaking down a learning process and then teaching each step in the order of its learning difficulties.

Since apprentice training was one of the earliest of A.F.A. activities, this review of foundry apprenticeship over the past 50 years is of considerable interest. Significant, however, is the fact that, as the author points out, much remains to be done especially in greater understanding by foundry executives of the value and importance of training apprentices. The author, a member of the Apprentice Training Committee, is connected with a company which long has been noted for its interest in this phase of employee training.

A.F.A. First to Act

Perhaps the first organized effort in this country to promote apprenticeship in foundries was made by the American Foundrymen's Association in 1896—fifty years ago. A start was made by forming an Apprentice Training Committee, which was the first of the long line of conference groups now under the sponsorship of this Association. It is a matter of pride to the Brown & Sharpe Manufacturing Co. that the late Richmond Viall, who for many years served as Works Superintendent, was a member of this first committee.

In 1897 the committee presented recommendations for standards of apprenticeship in the foundries. This was the forerunner of a great many effective measures that have been instituted by the Association's Apprentice Training Committee over a period of a half century.

At the first A.F.A. Convention in 1896, a paper discussing foundry training was presented by J. D. Matlach of I. P. Morris & Co., Philadelphia. The title was "Apprenticeship—Its Work and How to Make Molders."

It is interesting to note, also, that at the 1898 Convention, P. W. Gates of the Gates Iron Works, Chicago, presented a paper entitled "Molders of the Future." Mr. Gates presented some data which are interesting by comparison with our prevailing rates for apprentices.

The author stated that his 4-year apprentices worked a year of 300 days—10 hours a day and a 60-hour week. The apprentices were paid

$7\frac{1}{2}$ cents an hour for the first year; 10 cents an hour for the second year; $12\frac{1}{2}$ cents an hour for the third year, and 15 cents an hour for the fourth year.

It may be argued that the foundry of fifty years ago did a very good job with apprenticeship and with the development of leaders, but it also must be admitted that we have gained valuable knowledge over the years concerning numerous techniques which make for much more efficient operation and the production of a better quality of castings. Good castings were made fifty years ago, but not one of us today would think of trying to carry on our business as we did fifty years ago—or even ten years ago.

With the coming of the molding machine, about the time the American Foundrymen's Association was founded fifty years ago, apprenticeship training declined, and the foundry industry had to depend to a considerable extent on men trained in Scotland, England and Germany. However, the A.F.A. Apprenticeship Committee continued over the years to emphasize to management the need for reviving organized training in order to supply the American foundry industry with skilled personnel.

In the early 1920's definite progress was made and some industrial centers, notably Wisconsin and the Quad City group, cooperated with the state and local school systems in sponsoring organized foundry apprentice training, with the schools delegated to giving instruction on what we call "related subjects." The school instruction was mandatory in character.

A.F.A. Contests Begun

This revival of interest in apprentice training brought about the beginning of the A.F.A. apprentice molding and patternmaking contests, which were initiated in 1924. In these contests individual plants and groups, such as local foundry associations, sponsored contests under four headings: Gray iron molding, steel molding, non-ferrous molding, and patternmaking.

These contests have been held annually since that time, with countrywide participation. Several foundries connected with the Association have carried on outstanding work in apprentice training, and many of their apprentices have been winners in the national competition.

It is interesting to note that the 1945 contest included, for the first time, entries from north of the border, and it is gratifying to report that foundry apprentices in Montreal received several of the contest prizes.

4-Year Course Introduced

In the late 1920's the A.F.A. Committee submitted for approval the A.F.A. Recommended 4-Year Apprentice Molding and Patternmaking Courses. These courses also were recommended by the U. S. Committee on Apprentice Training.

The A.F.A. Committee, through its annual meetings, talks and papers, has been endeavoring constantly to interest management in organized training. Although much of our apprentice training work necessarily ceased during the war, it should go forward more effectively now than ever before, since the need for trained men as leaders is becoming one of the greatest problems of the foundry industry. Such leaders will be needed to meet competition from other materials and methods of manufacture.

Along with the knowledge we have gained concerning improved techniques, we have learned that there is more to apprenticeship than simply taking a boy because his father is a molder and turning him over to a foreman, with an order that the boy is to learn the trade. For one thing, the boy of today generally does not apply for a foundry apprenticeship because his father is a molder. In fact, it has been found that the opposite is quite true.

The foundry is known to the layman as a place where only hard and dirty work is done. Without public relations, the foundry industry must look to its individual members to acquaint the boys of their respective communities with the possibilities both for learning the trade and for development thereafter.

Early Educational Work

About twenty-five years ago there appeared a consciousness of this obligation. A few foundries published booklets, expressly for the purpose of interesting boys in the trade of molding. One company, taking apprentices from all over the country, started a dormitory for apprentices, primarily with the thought of making foundry training more attractive.

During the last decade a growing awareness of the need for modernized apprenticeship in our modernized foundries has been reborn. The war years have helped to bring us face to face with a serious shortage, not only of skilled molders but also of men with both leadership qualities and the necessary background of training and experience.

The history of apprenticeship in the foundry may not be something to which we can point with pride. Perhaps this is due, in part, to our concentration on machines and materials. There will come a time, however, when our managers, superintendents, foremen and skilled artisans of today must be replaced. If we have no plans for that time, we are as remiss as we would be if we failed to provide for depreciation and obsolescence of plant and equipment.

The Next 50 Years

Let us hope that a history of foundry apprenticeship covering the next fifty years can give the same importance to the selection, training and promotion of young men in the industry as it no doubt will give to advancements in equipment, materials, and processes.

We may hope, by breaking down our jobs into small, specialized segments, to obviate the need for the skills that constitute a trade. We already have war production and a considerable period preceding as proof that necessity has made possible many things that years ago we would have thought beyond all reason.

We know that always there will be a need of men with an over-all knowledge of how to produce castings. Even in the highly specialized foundry there must be the coordinator, the planner, the estimator, and the leader of those who specialize.

Such men cannot be hired from among the applicants for jobs. They must be made, and preferably, made in our own foundries. If the making of such men is done with the care that we exercise in other aspects of foundry management, the history of apprenticeship in the foundry from this day forth will be a better one than it is possible to write at the present time.

GRAY IRON GROUP

Presents Aggressive Scope Program

ONE OF THE MOST AMBITIOUS programs undertaken by any group in A.F.A. is the current series of activities sponsored by the Gray Iron Division. Under the leadership of divisional chairman T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa., a series of important projects has just been completed, of incalculable value to the entire gray iron industry.

The new CUPOLA HANDBOOK of the Association, to be displayed at the Convention in Cleveland for the first time, represents the work of over five years of planning, study and intensive discussion by scores of outstanding metallurgists and operating men. An undertaking of the Cupola Research Project, administered by the A.F.A. Technical Development Program in cooperation with divisional leaders, the Handbook is the most complete and authentic work ever published on cupola operation, and will be widely distributed.

New Cupola Handbook

Proceeds from the sale of the new Handbook will be turned back into the Cupola Research Project for further gray iron studies as yet unannounced.

An outstanding part of the Gray Iron program at the 50th Anniversary Foundry Congress will be the symposium on engineering properties of gray cast iron, prepared especially for consumption of design engineers and other casting users. Highly comprehensive, the symposium will be prepared in printed form for broad distribution by gray iron foundries among the engineers who control the design, specification and purchase of metal parts.

Castings Defects Study

Another important activity of the Gray Iron Division is the comprehensive study of casting defects made by the Committee on Casting Defects. This work was begun some five or six years ago, at which time several articles sponsored by the committee appeared in AMERICAN FOUNDRYMAN (see issues of Dec., 1941; Jan., 1942; Feb., 1942; March, 1942; May, 1942; July, 1942). Elements of the current expanded study are to be presented during the convention at two sessions of the Gray Iron Shop Course.

The first phase of this project of the Committee on Castings Defects, a study of "Defects Attributable to Metal," has now been completed and will be published first in AMERICAN FOUNDRYMAN over the next several months, beginning with the June issue, after which it will be made available in book form. It constitutes one of the most practical and comprehensively illustrated studies ever made by an A.F.A. committee, and has been produced under the chairmanship of W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee.

The Committee on Casting Defects now is embarking on the second phase of its important study, the presentation of remedies for casting defects. Thus the complete work will be of intensely practical value and usefulness.

Shop Operation Course

In addition, the Gray Iron Division is the only A.F.A. division now sponsoring a shop operation course at the annual meetings. This year's shop course includes four sessions and, conducted primarily as "off the record" discussions, is expected to maintain the experience of previous shop courses which have proved to be one of the most popular of convention events.

The record of the Gray Iron Division thus is one of continuous, progressive enthusiasm in achieving a wider spread of knowledge concerning gray iron, and accounts largely for the constantly increasing interest shown by gray iron foundrymen in A.F.A. activities. It should be emphasized, however, that the activity of any division of the Association is largely a reflection of the desires of the membership.

English Engineers Test Cast Iron Crankshafts

UNDER A PROGRAM of research recently drawn up, an investigation is under way into the effect of certain design features upon the fatigue properties of cast iron crankshafts, according to the annual report of the Automobile Research Committee, Institution of Automobile Engineers, London, England, and noted currently in *Foundry Trade Journal.*

Design characteristics under consideration include: fillet radius, fillet profile, surface finish, thickness and width of webs, crank throw, overlap, length and diameter of crankpin, shape of web profile, and various special designs of web and cored holes incorporating stress-relieving features.

For the purpose of the investigation, single throw crankshafts of one particular cast iron, from the same foundry, are obtained. In the future it is planned to continue the study with different irons, with cast steels, and varying surface finishes, as well as different designs.

Specialized Procedures

The slow rate of crack propagation in cast iron has necessitated development of a special testing technique which incorporates a method of detecting cracks without halting the test. When the first detectable crack apears the shaft is regarded as having failed.

According to report, no difference is to be expected with this method of test between results obtained with present constant-strain machines and those obtained in a constant-stress machine.

Along with the determinations on the crankshafts themselves, subsidiary tests are in progress on test bars cast at the same time as the specimens; the object being to obtain information as to any correlation between the properties of the material and the fatigue characteristics of the part. Test bars cut from the shafts themselves are also subjected to such investigation.

Transverse bending, hardness, and rotating bending fatigue tests are applied to the bars.

Under present plans, extensometer tensile tests, as well as impact and torsion tests, will be undertaken. Resistance of notched bars to bending fatigue, together with resistance of bars to fatigue under torsion—and possibly under combined torsion and bending stresses—will be measured. Chemical composition, damping capacity, and microstructure are also to be examined.

Further, the design and construction of a special machine to design torsional fatigue tests directly to crankshaft specimens is under consideration.

REPORT OF THE SUBCOMMITTEE

GRAY IRON

FOUNDRY SANDS

The Subcommittee on Physical Properties of Gray Iron Foundry Sands at Elevated Temperatures, Foundry Sand Research Project of A.F.A., adopted the procedure of first devising pattern and testing equipment, followed by actual foundry work. Laboratory research work under way should yield test methods of practical value.

Subcommittee on Physical Properties of Gray Iron Foundry Sands at Elevated Temperatures

THE FIRST MEETING of this subcommittee was held Oct. 30, 1944, at Detroit. The duties of this subcommittee were outlined as the formulation of test methods that will be required by the gray iron and malleable iron foundries to measure the elevated temperature physical properties of iron molding materials and to set up performance specifications of the necessary testing machines.

The subcommittee agreed to first attack the problem of developing a test method whereby the shakeout effort required to remove cores from castings could be measured by a quick laboratory test. The first step in the program was to devise two sets of pattern equipment which could be used in the foundry to produce first a test casting with a relatively light metal thickness as compared to the thickness of the core. Details of this test casting are given in Fig. 1. This casting is to be poured with gray iron at a measured temperature using core mixtures of various compositions to secure a wide range of mechanical work to remove the core from the casting. This work is to be expressed in time of jolting required to remove the core from the casting.

The second test pattern setup,

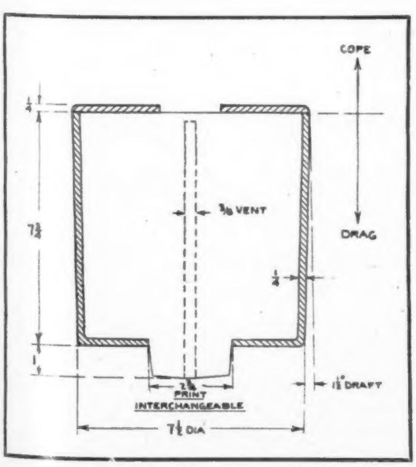


Fig. 1—Test casting for evaluating ease of core knockout of different core mixtures.

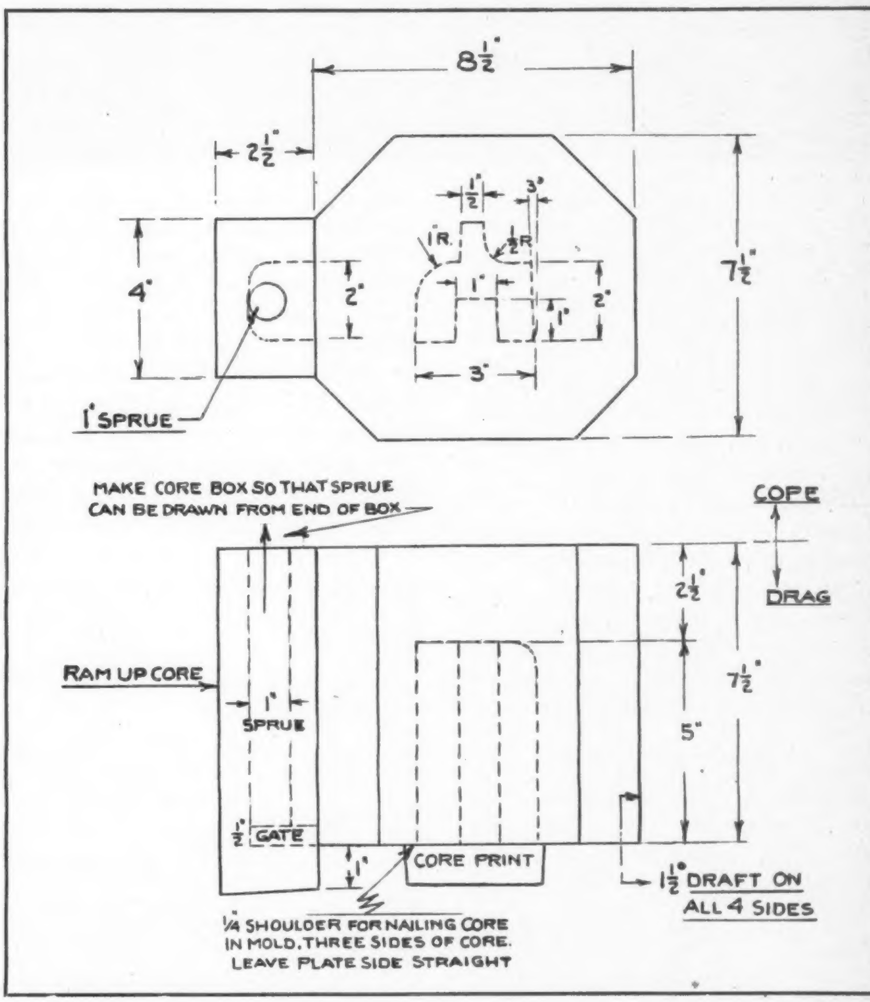
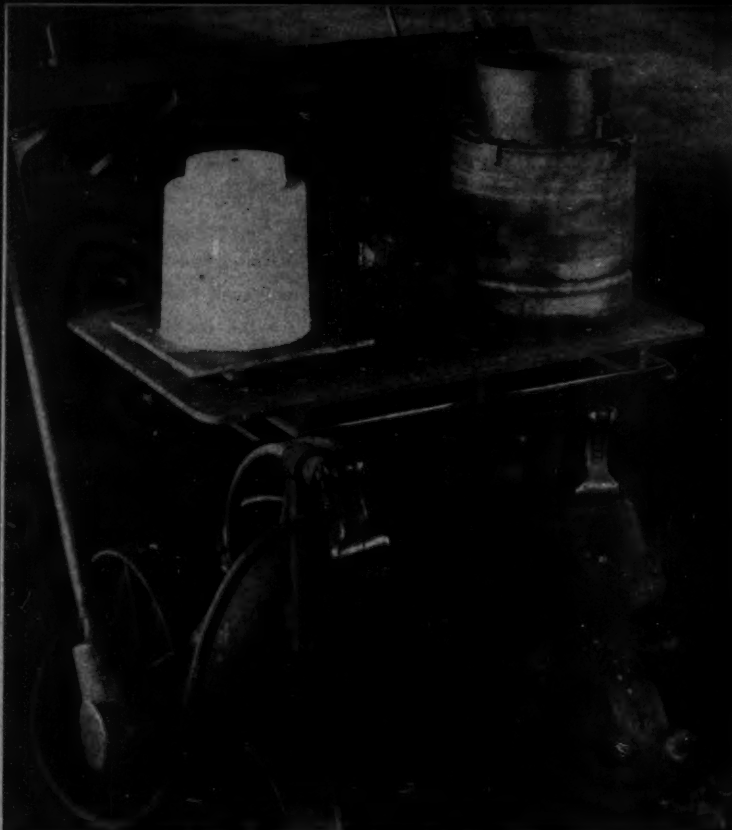


Fig. 2—Test casting for measuring the degree of penetration, quantity of veining, and quality of surface.



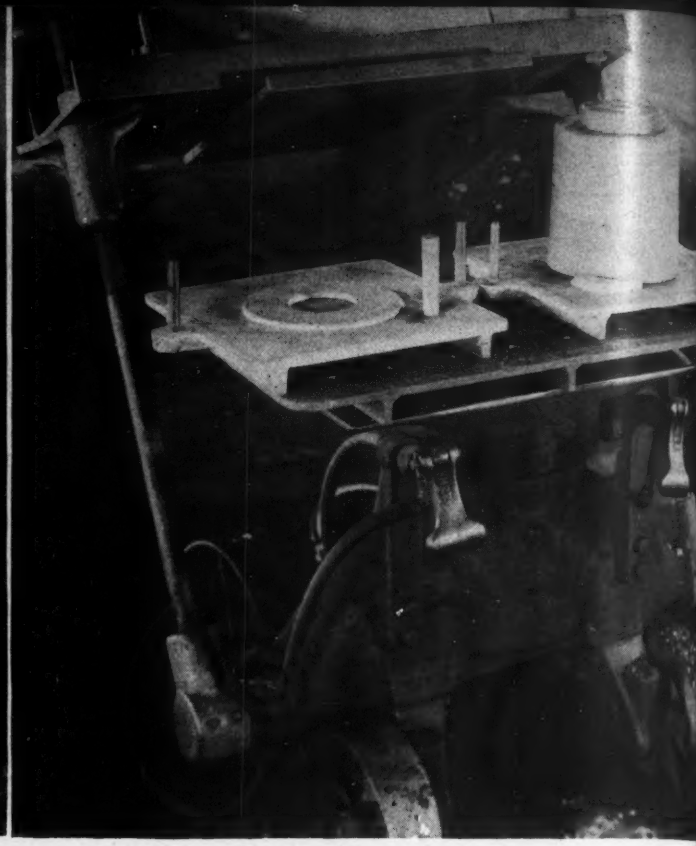


Fig. 3—(above) Core knockout pattern equipment for making the knockout test core. Fig. 4—(right) Pattern equipment used to make the mold for core knockout test casting.

as detailed in Fig. 2, is to be used to measure the degree of penetration and veining, also the quality of cored surface. The metal, at a controlled temperature, is to be cast against cores of different composition. From these foundry test castings, these various core mixtures are to be graded as to the ease of shakeout, degree of penetration, quantity of veining and quality of surface.

Laboratory Evaluation

After this program, these same core mixtures are to be tested in the laboratory, endeavoring to devise test methods that will evaluate these cores in the same order of ease of shakeout, degree of penetration, quantity of veining and quality of surface.

At the present time, all of the pattern and core equipment has been constructed. The core equipment for the core knockout effort test is shown in Fig. 3, while the molding and pattern equipment is shown in Fig. 4. Two penetration test cores are shown in Fig. 5 as used for studying veining, surface finish, and penetration. Associate Professor W. A. Spindler and John Grennan of the University of Michigan, Ann Arbor, where the foundry tests will be made, have cast a number of trial castings from this equipment.

The question as to the size of a laboratory test furnace that should be used in this problem has been raised. The majority of the dilatometer furnaces used are equipped with a furnace with a 2-in. inside diameter hearth. Two larger dilatometer furnaces which are available for this investigation have hearths with an 8-in. inside diameter, having an available inside diameter of 4½ in. with an 11-in. length.

The heat transfer into a 1⅛x2-in. sand specimen is shown in Fig. 6 for these two sizes of dilatometer furnace. It may be noted that there is very little difference in the rate of heat transfer. The sand specimen reaches a furnace test temperature

Table 1

Test Core Mixtures and Properties

Mixture	*Material*	*Percentage*	*Moisture in Test, per cent*	*Flowability*	*Green Compression Strength, psi.*	*Core Permeability*	*Tensile Strength, psi.*	*Weight 2-in. Specimen grams*	*Baking Temp., °F.*
No. 1	Michigan City sand Oil Water	99 1.0 3.6	2.9	88	0.25	184	140.5	161	425
No. 2	Michigan City sand Michigan bank sand Cereal binder Water Oil	70 28.3 0.5 4.5 1.2	3.9	91	0.4	125	185	166	425
No. 3	Michigan City sand Silica flour Western bentonite Cereal binder Water Oil	87 10. 0.5 1.0 5.4 1.5	5.1	86	2.0	95	164	175	425
No. 4	Hayville gravel Heap sand Pitch compound Water	49.0 49.0 2.0 7.5	7.45	70.5	4.1	56.4	15.5	185	425
No. 5	Michigan City sand Heap sand Cereal binder Resin Water	15.0 81.5 0.5 3.0 8.5	7.6	68	9.25	66.1	17.5	162	400

of 2500° F. at the same time of 8 min. for either furnace.

The rate of heat transfer is slightly faster for the large furnace in the first 15 sec. where the moisture is converted to steam. This faster rate of heat transfer is distinguishable but not of sufficient practical magnitude as this sand specimen temperature increases up to 2000° F.

The subcommittee's method of first securing practical foundry evaluation and then proceeding with the laboratory research work should yield test methods that will be of real practical value.

The second meeting of this subcommittee was held at the foundry of University of Michigan from June 4 to 7, inclusive. At this meeting the core knockout effort was measured and degree of penetration was studied by actual foundry casting tests.

Preparation of Core Sands

All ingredients of core sand mixtures were weighed carefully and mixed in a size 0 muller-type mixer. Dummy batches were prepared before test batches were mixed to condition the surfaces of the mixer. The compositions of core mixtures for the five different core sand mixtures employed are given below, as are the order of adding ingredients and length of mixing time.

Mix No. 1—Ingredients: Lake sand and oil added. Mixed 4 min. Water added and mixed 6 min.

Mix No. 2—Ingredients: Lake sand, bank sand, and cereal binder added. Mixed dry 2 min. Water added and mixed 4 min. Oil added and mixed 4 min.

Mix No. 3—Ingredients: Lake sand, silica flour, western bentonite and cereal binder added. Mixed dry 2 min. Water added and mixed 4 min. Oil added and mixed 4 min.

Mix No. 4—Ingredients: Hayville gravel, heap sand and pitch compound added. Mixed dry 2 min. Water added and mixed 6 min.

Mix No. 5—Ingredients: Lake sand, heap sand, cereal binder and resin added. Mixed dry 2 min. Water added and mixed 6 min.

Coremaking. Six shakeout test cores were made of each core mix. The cores were rammed with 25 jolts on jolt machine with a 3-in. drop and with a 18.5-lb. weight resting on top of the sand. Four block penetration cores were made of each core mix, employing ten jolts with a 7-lb. weight resting on top of sand and ten additional rams with ten drops of 7-lb. weight falling 6½ in.

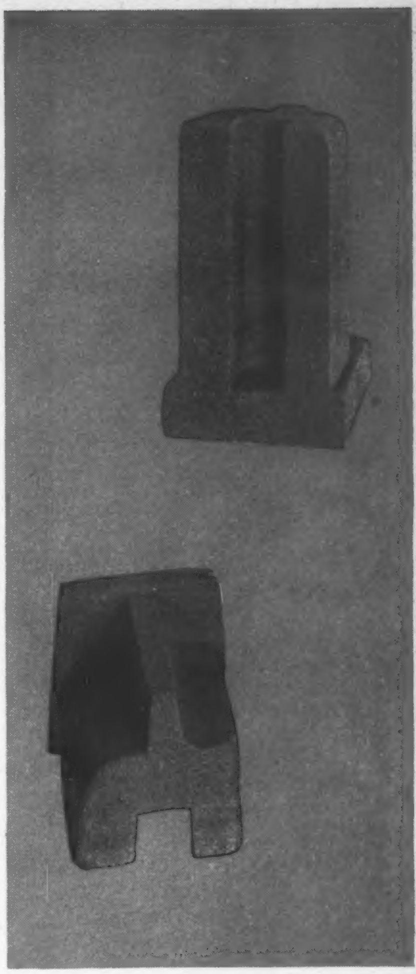


Fig. 5—Type of core used in penetration study.

For laboratory tests, the following test cores were prepared for each mix in accordance with A.F.A. specifications or approved methods:

- 6—Tensile cores.
- 300—1⅛x2 in. dilatometer test cores.
- 3—Core permeability cores.
- 3—Confined expansion cores.
- 3—Hot gas pressure cores.

Core Baking. All cores were fired in a foundry core oven at time and temperature as shown in Table 1.

Molding. All molds were made with well prepared heap sand which tested:

Green Permeability..............36.0
Green Compression, psi....... 7.1
Moisture, per cent................ 9.2

All molds were rammed with 25 jolts with a drop of 3 in. Aluminum flasks and bottom boards were used with cast iron weights clamped in place. All the sand molds were numbered.

Metal. The molten metal was obtained from an indirect-arc, electric, rocking type furnace. Metal analysis

Table 1

TEST CORE MIXTURES AND PROPERTIES

Weight 2-in. Specimen grams	Baking Temp., °F.	Baking Time, hr. Foundry Core, hr.	Baking Time, hr. Test Core, hr.	Average Top 100's	Average Bottom 100's	Average Pouring Temp., °F.	Casting in Mold, hr.	Casting Cooling Time, hr.	Core Knock-out, sec.	Knock-out Sand Temp., °F.	Order of Finish
161	425	5	3	65	76	2740	1	4.5	5.6	112	4
166	425	5	3	68	90	2692	1	4.5	44	106	1
175	425	5	3	83	90.5	2746	1	4.5	315	138	3
185	425	5	3	81	78	2650	1	4.5	479	103	5
162	400	4	3	40	60	2765	1	4.5	18.6	137	2

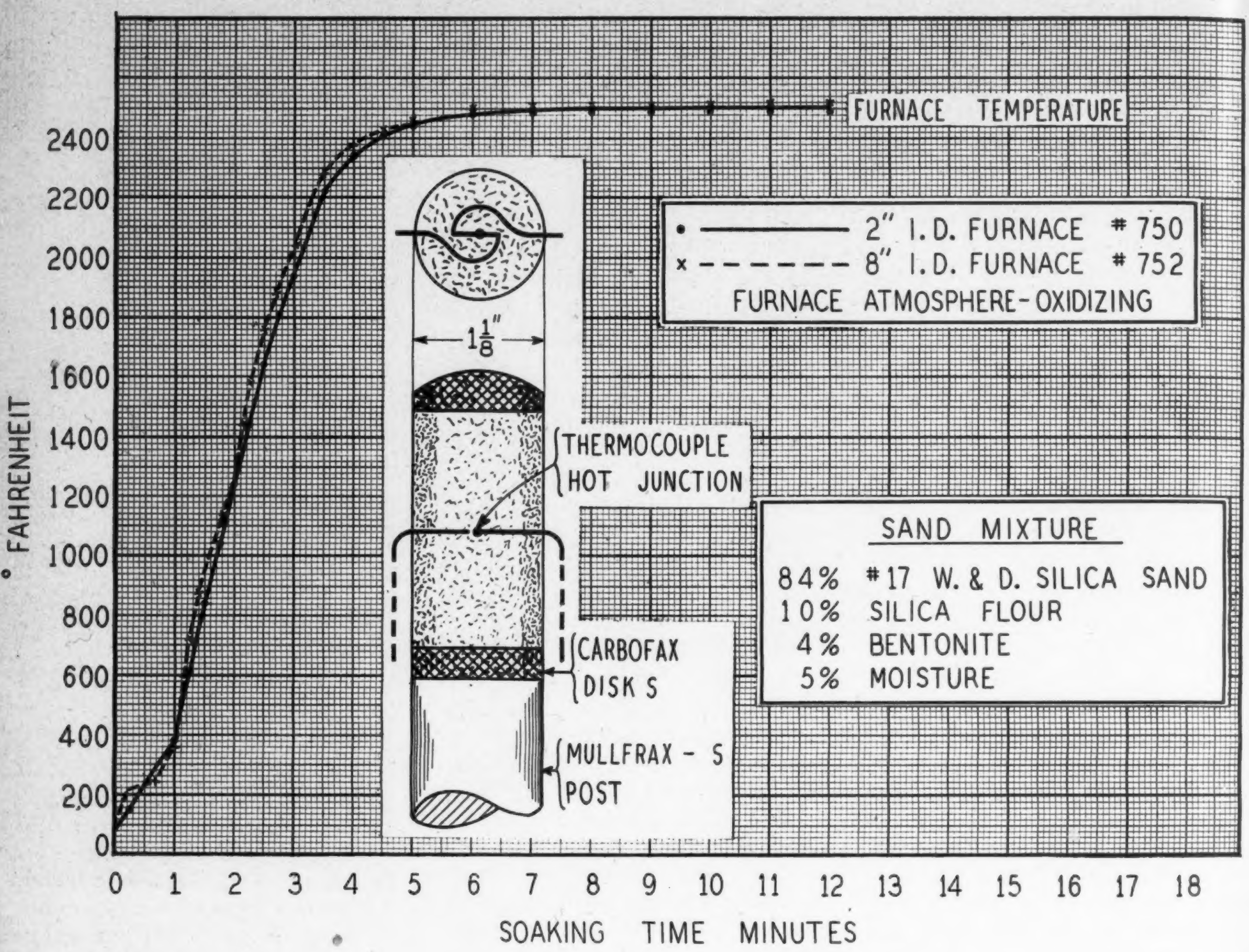


Fig. 6—Heat transfer into a 1⅛x2-in. sand specimen when inserted into two different sized furnaces.

of the mixes are shown in Table 2.

Metal was tapped from furnace at 2800° F. ±50° F., using an optical pyrometer for temperature measurements. The molds were poured with a 150-lb. double-shank ladle and metal temperature readings were taken. See Table 1 for average pouring temperatures.

The penetration test castings shown in Fig. 7 were made on the first day, and no more of these castings were made since no penetration was experienced with the electric furnace iron of the composition used. Committee members have experienced penetration with this test pattern when using cupola metal. A report will shortly be made covering this phase of the work.

Casting Cooling Time. After the core knockout test molds were

Table 2

METAL ANALYSIS

Component	Mix Number 1	2	3	4	5
Silicon, per cent	2.29	2.26	2.16	2.40	2.36
Total Carbon, per cent	3.11	3.12	3.02	3.20	3.16
Combined Carbon, per cent	......	......	......	......	......
Manganese, per cent	0.54	0.63	0.53	0.61	0.61
Phosphorus, per cent	0.269	0.273	0.318	0.311	0.276
Sulphur, per cent	0.095	0.101	0.101	0.082	0.090

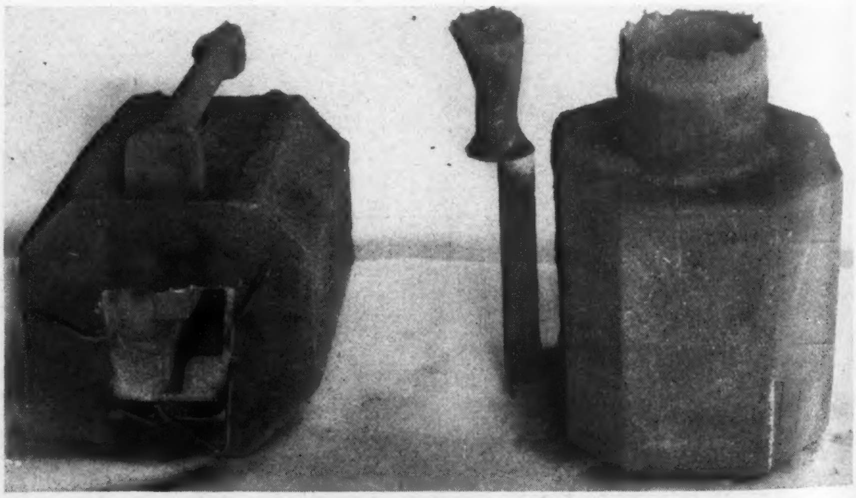


Fig. 7—Penetration and veining test castings made from electric furnace iron.

poured. They were allowed to cool for a period of one hour before the castings were removed, and then the castings were allowed to cool for a period of 4½ hr.

Core Knockout. To measure the energy required to remove the cores from the castings, a casting holding fixture was bolted to a jolt machine with a 3-in. ram drop, as illustrated in Fig. 8. The time in seconds of jolting required to remove the core from the test casting was used as the index of core removal energy. This method of test worked satisfactorily. The knockout time is shown in Table 1. A very good spread of knockout time was secured. This gives a very good start for correlation of knockout time with high temperature test method research work. The core knockout time for the five cores under test is shown in Fig. 9.

Laboratory tests at elevated temperatures are now under way on core specimens made at the time the casting cores were made.

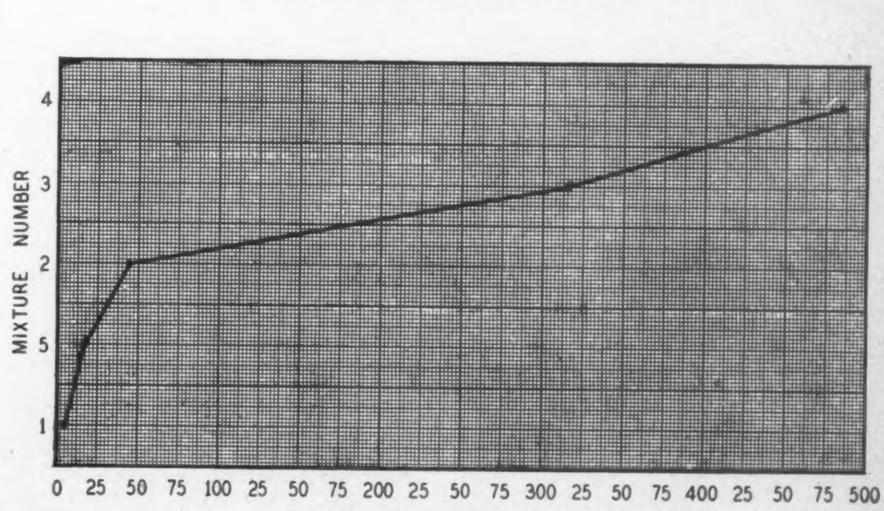
All members present at the June meeting agreed to make additional foundry penetration tests. Test castings will be made by Messrs. Satz, McMurray and Olsen. The problem of penetration, while extremely interesting, is difficult to reproduce.

It was agreed that correlation between foundry knockout effort and laboratory tests will form our major problem, carrying along the research on foundry tests on penetration as a minor problem.

Personnel of the Subcommittee on Physical Properties of Gray Iron Foundry Sands at Elevated Temperatures at the time this report was prepared was as follows: H. W. Dietert, chairman; Day E. Cutler; J. Schumacher; J. A. Gitzen; Wm. A. Spindler; H. G. McMurry; Leon B. Thomas; John Grennan; D. C. Williams; E. W. Olson; George F. Watson; E. C. Zirzow; and Arnold Satz.

Fig. 8—Core knockout equipment as developed for measuring work required to remove core from test casting. Committee members conducted tests at University of Michigan foundry.

Fig. 9—(below) Spread of knockout time for removal of the five types of cores under consideration in these tests.



MICROPOROSITY IN MAGNESIUM ALLOY CASTINGS

Interrelation of various major factors determining amount of microporosity in magnesium alloy castings . . . part of general program sponsored by Office of Production Research and Development of WPB . . . published with permission of Office of Production Research and Development of Civilian Production Administration.

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MICROPOROSITY IS A DEFECT which is by no means confined only to magnesium-base casting alloys. Because the principal uses of magnesium castings have been for aircraft, the quality standard has been high and the defect known as microporosity has received much public attention. As a result of this publicity, many users of castings have been led to believe that microporosity is a defect peculiar to magnesium alloys.

As a matter of fact, some aluminum-base alloys and many copper-base alloys are subject to this defect. All of these alloys, regardless of the base metal, have certain characteristics in common which make them subject to microporosity. These general characteristics, the factors involved, and the mechanism of the formation of microporosity have been described.[1] However, it will be well to review this phase of the problem before presenting the results of the investigation described herein.

Microporosity Formation Mechanism. The general factors involved are shown by Fig. 1, which represents any given section in a casting, vertical, horizontal, or inclined, fed by a riser, and chilled to promote directional solidification. Although the section shown by Fig. 1 is vertical, the principles are the same regardless of the shape or position of the section in the casting.

When the metal is poured through the sprue and ingate (Fig. 1), the metal gradually rises in the mold cavity. At the instant the mold cavity is filled, the hottest metal and hottest portion of the mold cavity are at the bottom adjacent to the gate, while the coldest metal and coldest part of the mold cavity are at the top of the riser. This temperature gradient is the reverse of that which is desired.

It is necessary to make this particular section solidify from the bottom toward the riser. To accomplish this it is necessary to reverse the temperature gradient which, in this particular instance, is effected by the use of a riser at the top and a chill at the bottom. The temperature gradients are thus reversed, and the casting begins to freeze adjacent to the chill, solidification proceeding upward toward the riser.

At any particular time during the process of solidification of the casting, the section will be solid at all temperatures below the solidus temperature, t_s (Fig. 1). Likewise, the section will be entirely liquid above the liquidus temperature t_L.

Between these two temperatures, the section will be partially solid, and this portion of the metal is referred to as the "mushy zone." The liquid content grades from 100 per cent at t_L to zero per cent at t_s. The greater the length of this mushy zone, the greater the difficulties of compensating for the solidification shrinkage.

Hence, there may be some temperature such as t_c (Fig. 1), below which the mushy zone contains such small liquid channels that it is impossible for the liquid metal to feed through them and entirely compensate for the solidification shrinkage of the alloy.

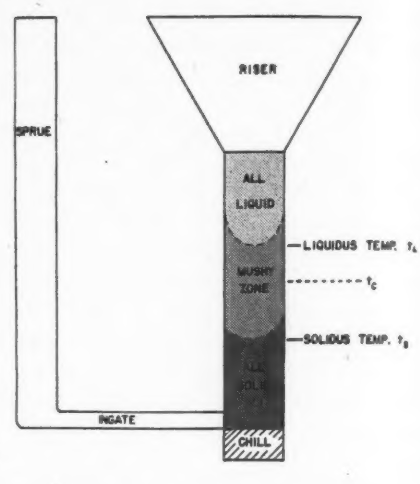


Fig. 1—Sketch showing formation of a mushy zone during solidification.

Crystallization Range

All other factors the same, the greater the length of the zone lying between the temperatures t_s and t_c, the greater the amount of microporosity which will be formed; and the greater the temperature interval between t_s and t_c, the greater the total liquid contraction.

If gas is precipitated from the melt during solidification, it fills the voids and greatly hinders the flow of melt into these small cavities. If the gas content of the melt were nil, the vapor pressure in the small cavities would be equivalent to the vapor pressure of the metal which would, of course, be very low. The small voids would then be essentially a

This paper will be presented and discussed at an Aluminum and Magnesium Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6-10, 1946. Oral and written discussions solicited.

high vacuum, and atmospheric pressure would help to force the liquid metal into them.

It is logical, therefore, that the greater the gas content of the melt, the greater the tendency to form microporosity. If the gas content of the melt is very high, some of the gas will be precipitated early in the process of solidification and macrovoids will be formed, such as the well-known pinholes in aluminum and copper-base alloys and the larger gas holes produced in magnesium alloy at very high gas content.

It is also logical that the length of the mushy zone, all other factors the same, will be more pronounced the greater the solidification range of the alloy and the lower the amount of eutectic liquid formed. Consequently, solid solution type alloys, which have little or no eutectic liquid solidifying at the end and which generally solidify over a considerable range in temperature, are the most prone to the formation of microporosity.

Thus, the occurrence of microporosity will depend to a considerable extent upon the alloy composition, since the composition will largely determine the amount of eutectic and range in solidification.

It is also evident that the length of the mushy zone will be shorter the steeper the temperature gradient in the solidifying section. Much more metal is provided in the riser than is required to feed the voids resulting from solidification shrinkage.

The principal function of the riser is as a heat reservoir which will establish temperature gradients increasing toward it. This problem of providing adequate temperature gradients toward the risers involves the entire one of proper gating, risering, and chilling the casting to produce sound metal.

Experimental Work

It is thus evident that the principal factors which determine the occurrence of microporosity in a casting are (1) the alloy composition, (2) the gas content of the melt, and (3) the steepness of the temperature gradient toward the feed reservoirs. The interrelation of these three factors to the occurrence of microporosity will now be considered.

The investigation of the effect of the steepness of the temperature gradients has been limited to the determination of the effect of section thickness and of riser size on horizontally cast plates gated and risered on one end. Investigation of the effect of alloy composition has been restricted to a comparison of the four most common American and European casting alloys.[5] These alloys have the nominal composition shown in Table 1.

The gas content of the melts has been investigated over a range which might normally be expected to occur under commercial practice. None of the melts contained sufficient gas to cause the risers to rise, forming a convex surface, or to form microscopic voids in the casting. However, gas content was encountered which was sufficient to accentuate greatly the microporosity, and which did produce unsound metal over the entire vertical length of a wedge casting used to measure the gas content of the melt. Use of the wedge casting, illustrated by Fig. 2, has been described elsewhere.[2] In general, the lower the gas content of the melt the greater the height of sound metal in this wedge.

If the gas content of the melt is relatively high, microporosity will occur from the bottom to the top of this casting. As the gas content is decreased, the height of sound metal measured from the bottom of the wedge will increase until a maximum of about 3⅓-in. of sound metal is obtained with best quality melts.

The height of sound metal is determined by cutting a vertical ⅜-in. section from the center of the wedge casting, facing it off, and x-raying the resulting section to show the occurrence of microporosity. Under these conditions, the x-ray is very sensitive and very small amounts of microporosity are revealed.

Table 1

NOMINAL COMPOSITION OF THE ALLOYS INVESTIGATED

Alloy	—Components, per cent— *Al*	*Zn*	*Mn*
A-8	8.0	0.4	0.2
AZ-91	9.4	0.4	0.2
ASTM-AZ63*	6.0	3.0	0.2
ASTM-AZ92**	9.0	2.0	0.2

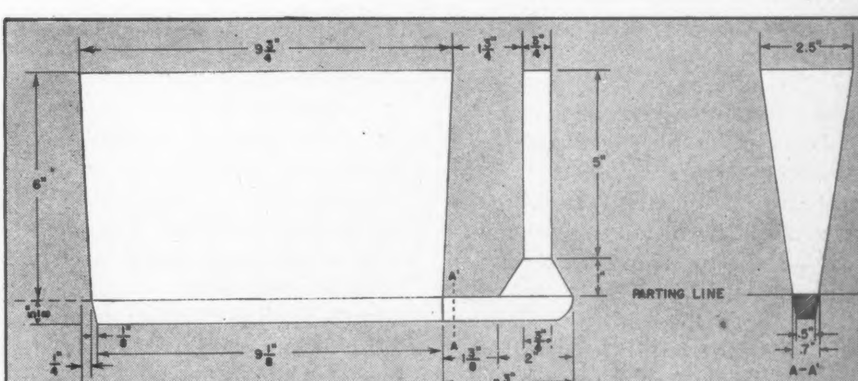
*Formerly designated ASTM-4.
**Formerly designated ASTM-17.

Relationship of Alloy Composition, Gas Content of Melt, and Section Thickness to Occurrence of Microporosity. One melt of each of the four alloys was prepared with a relatively high gas content by stirring unfused No. 310 flux into the melt. Four heats of ASTM-AZ63 and A-8, three heats of AZ-91, and five heats of ASTM-AZ92 were prepared and degassed by chlorine fluxing.

Grain refinement was obtained by various methods, including superheating and carbon inoculation with natural gas, and by the inclusion of carbon tetrachloride vapor in the chlorine, as described elsewhere.[3, 4] A typical synthetic sand was used with ethylene glycol, boric acid, and sulphur as the inhibitors.

In addition to the wedge casting

Fig. 2—Views of the wedge casting used in the investigation.



(Fig. 2), various plate castings 6 in. wide and 10 in. long of various thicknesses were cast horizontally. Plate thicknesses were 3/16, ⅜, ½, ¾, 1, and 1½ in., and all were gated on one end with the riser placed at the gate end. The 3/16-in. plate is shown in Fig. 3. The other plates were identical to this, except that the plate thickness was greater.

Pouring temperature was found to have little or no effect upon the occurrence of microporosity in these plates. Accordingly, the variations which occurred while pouring a series of molds were of little consequence to the results obtained. However, pouring temperatures were kept between 1500 and 1350° F., the highest temperature being used for the thinnest plates.

One wedge casting and the six 6x10-in. flat plates, varying in section thickness from 3/16 to 1½ in., were poured from each heat. Plates which are of ½-in. or more thickness are not suitable specimens from which to obtain radiographs that reveal accurately all of the microporosity present.

Consequently, such plates were sectioned lengthwise into three vertical, parallel sections. One of these vertical sections was cut from the center of the plate; the other two from midway between the center section and each edge. These sections were machined to ⅜ in. and then radiographed.

The 3/16- and ⅜-in. plates were radiographed in entirety; and such microporosity as was present tended to be widely distributed, i.e., it would occur at either end and generally across the plate. On the other hand, any microporosity in the ½-, ¾-, and 1½-in. plates would occur in the end adjacent to the riser, and would be more severe in the center section than in either of the two side sections.

A fairly satisfactory rating could be obtained by measuring the number of inches of sound metal in the center section. Since the plates were 10 in. long, the rating would be No. 10, if the entire length of the section was sound. If 4 in. of the center section were sound, the radiographic rating would be 4. If the center was unsound over its entire length, the radiographic rating would be 0, etc.

In all instances, the center section would exhibit more unsoundness than either of the two side sections. This is also true of the 3/16- and ⅜-in. plates which were radiographed over the entire surface. The length in inches of sound metal along the center line of these plates was also taken as the radiographic rating, as described previously.

However, since the microporosity tends to be more generally distributed across the 3/16- or ⅜-in. plates, a porosity rating of 3, for example, might contain more widely distributed porosity across the plate in a thin section than in a heavy section. The rating as described is simple and has proved to be quite satisfactory. The average results obtained on the 20 heats are shown in Table 2.

Table 2

Effect of Alloy Composition, Gas Content,[1] and Section Thickness on Average[2] Porosity Rating[3]

(Riser thickness at the base adjacent to the casting was twice the plate thickness. The top of riser was ½ in. thicker than base of the riser, and all were 6 in. high.)

Section Thickness, in.	Radiographic Rating of Alloys: ASTM-AZ63		A-8		ASTM-AZ92		AZ-91[4]	
	Gassed	Degassed	Gassed	Degassed	Gassed	Degassed	Gassed	Degassed
3/16	0	2⅓	3	4¼	5	5½	10	7⅓
⅜	0	3½	1	8¼	0	8¾	10	10
½	0	6¼	0	6½	0	10	10	10
¾	0	6	0	9¼	0	10	10	10
1	0	5¾	0	9½	0	10	3	10
1½	0	½	0	3¼	0	9	0	10

[1] Gas content was indicated by the height of sound metal in the wedge casting. Gassed melts contained 0 in. of sound metal (see Footnote 4 below), and degassed melts generally produced over 2 in. of sound metal in the wedge.

[2] Only one gassed melt of each alloy was poured. Four heats each of ASTM-AZ63 and A-8 degassed melts, three heats of AZ-91, and five heats of ASTM-AZ92 were poured.

[3] Length in inches of sound metal in the center longitudinal vertical section of the plate (see text).

[4] This heat was only moderately gassy, as it produced 1⅛ in. of sound metal in a wedge casting.

Discussion

The conclusions from the data listed may be summarized as follows:

1. When the thickness of the riser is twice the thickness of the plate, the 3/16- and 1½-in. plates are the most difficult to make sound. The ½-, ¾-, and 1-in. plates are the most readily made sound, while the ⅜-in. plate is intermediate between this group and the 3/16-in. plate.

2. Using the degassed melts as a criterion, the order of alloy composition having decreasing susceptibility to microporosity is as follows: ASTM-AZ63, A-8, ASTM-AZ92, and AZ-91 alloys. This rating holds for plates of all thicknesses, and the difference between ASTM-AZ63 and A-8 compositions is larger than that among A-8, ASTM-AZ92, and AZ-91 alloys.

3. Degassing the melt has improved the soundness of the 3/16-in. section, but the improvement effected is far greater in the ⅜-in. and heavier sections.

4. While ASTM-AZ63, A-8, ASTM-AZ92, and AZ-91 alloys show decreasing susceptibility to microporosity in all section thicknesses, it will be noted that greater soundness can be effected in the 3/16-in. section by changing the alloy from ASTM-AZ63 to one that is less susceptible to microporosity than is obtained by decreasing the gas content of the melt in the range investigated.

5. It will be shown later that a ⅜-in. riser on a 3/16-in. plate is inadequate, and with degassed metal, the 3/16-in. section fed with a ¾-in. riser will, in general, be sound when poured in A-8, ASTM-AZ92, and AZ-91 alloys. The soundness of ASTM-AZ63, however, is increased but slightly if the riser on this 3/16-in. section is increased to ¾ in. or heavier. If then the 3/16-in. section had been fed with a 1-in. riser instead of a ⅜-in. riser, the data in Table 2 would have indicated a still further advantage of A-8, ASTM-AZ92, and AZ-91 over the ASTM-AZ63 composition.

6. It is only by a combination of a degassed melt and the selection of an alloy having the least susceptibility to microporosity that maximum soundness can be obtained for a given degree of feeding provided. It will also be shown that, in addition, adequate risering is necessary to produce substantially complete soundness.

Relation of Riser Size and Section

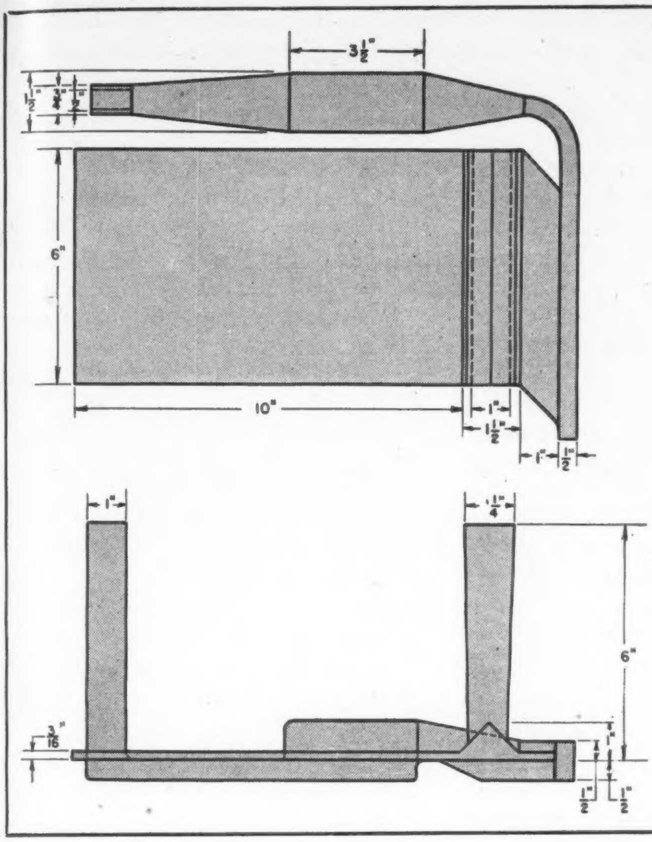


Fig. 3—Views of 6 x 10 x 3/16-in. plain plate test casting.

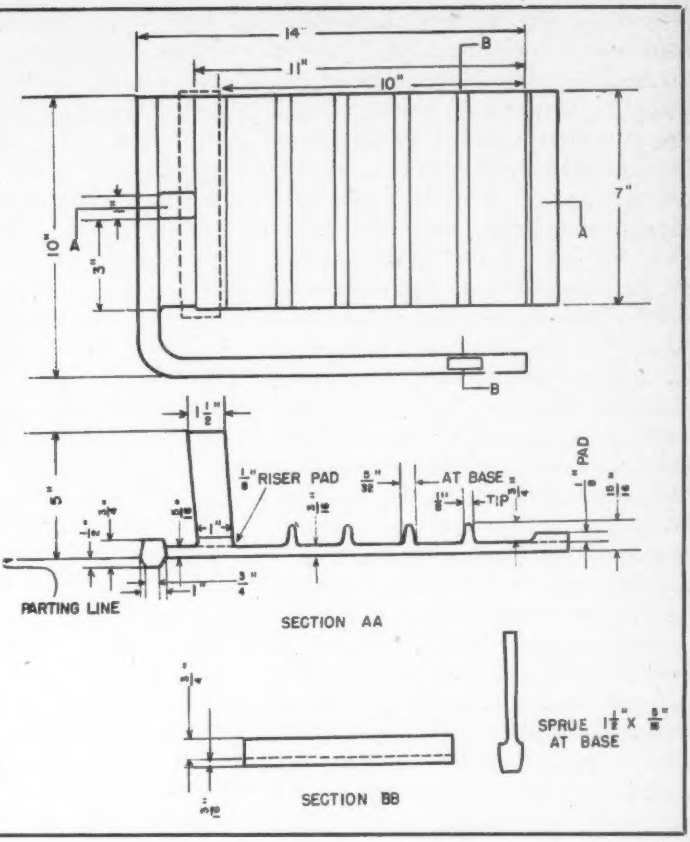


Fig. 4—Sectional views of 6 x 10 x 3/16-in. ribbed plate test casting.

Thickness to Occurrence of Microporosity in Castings of Four Different Alloys. The relationship of these factors to the amount of microporosity formed in castings of ASTM-AZ63, A-8, ASTM-AZ92, and AZ-91 was investigated. Four to six plates, similar to that shown by Fig. 3, were cast from each melt; but the plate thicknesses were varied from 3/16 to 1½ in. as described previously. Riser size was varied from zero to 3 in. at the base.

All risers extended across the width of the plate, were 6 in. high, and the thickness at the top of the risers was ½ in. greater than the thickness at the base. It should be emphasized that all of the plates were cast horizontally with the riser on one end and with the gate entering this riser.

This method of gating makes the temperature gradients all in the right direction at the instant the mold is filled. If it were necessary for the metal to flow through the mold cavity into the riser, as happens in many commercial castings, the results might vary somewhat from those reported here.

Each melt was thoroughly degassed by using chlorine or a mixture of chlorine and carbon tetrachloride and poured as wedge castings to indicate the melt quality. The considerable amount of sound metal in wedges poured from these heats indicated that all of the melts had a low gas content and, consequently, the results obtained are typical only of good quality, degassed melts.

Procedure

Nine heats of ASTM-AZ63 alloy were poured, producing a height of sound metal in the wedge of 2½ to 3½ in. Nine heats of A-8 alloy were poured in which the height of sound metal in the wedge casting ranged from 2 to 3½ in. Eleven heats of ASTM-AZ92 alloy produced 2¼ to 2⅞ in. of sound metal, and eight heats of AZ-91 alloy produced 2¼ to 3⅜ in. of sound metal in the wedge casting.

The 3/16- and ⅜-in. plates were radiographed in entirety and the ½-in. and heavier plates were sectioned and radiographed. These radiographs were rated from zero to 10, corresponding to complete unsoundness over the entire length to substantially complete soundness and freedom from microporosity. The results are listed in Table 3.

In some instances the porosity was very light or the microporosity was of the surface type only. Such surface microporosity apparently is associated with sand reaction and is not directly related to shrinkage or to the gas content of the melt. Accordingly, the data indicate the ratings in which a very light microporosity occurred as well as those ratings which are less than 10 and where only the surface type of microporosity occurs.

The portion of the data enclosed in parenthesis (Table 3) indicates the combination of plate thickness and riser thickness which will produce sound or substantially sound castings of each of the four alloys. The data listed in Table 3 indicate the following:

1. The 3/16-in. section is more difficult to make sound than the ⅜- or ½-in. section.

2. The 3/16-in. section can be made sound in A-8 alloy when the riser base is increased to ¾ in. and to ½ in. for ASTM-AZ92 and AZ-91 alloys. On the other hand, ASTM-AZ63 alloy cannot be made

sound in the 3/16-in. section regardless of riser size. The data tend to indicate that in the 3/16-in. section of ASTM-AZ63 alloy only a slight benefit is obtained by the riser, and certainly no additional benefit is obtained by increasing the riser base to a thickness greater than one in.

3. Table 4, based upon data taken from Table 3, indicates the minimum riser size required to produce substantially sound 6x10-in. plates of various thickness, cast horizontally and gated and risered on one end.

Investigations Using a 6x10x3/16-in. Ribbed Plate. A ribbed plate (Fig. 4) was also employed to check the relationship of alloy composition, gas content of the melt, degree of feeding provided, and the occurrence of microporosity in the casting. The distribution and amount of microporosity was determined by x-raying the entire plate.

This plate can be risered in various ways. Three-eighths-in. pads are attached to both ends of the plate, and a 1-in. riser may be placed at either end or at both ends. Thus, the relative merits of the following were determined: (1) gating into the riser, (2) passing the melt through the mold cavity to a riser at the end opposite the gate, (3) placing a 1-in. riser at each end, and (4) casting the plate without risers of any kind.

Two heats of ASTM-AZ63 alloy and one each of ASTM-AZ92, A-8, and AZ-91 alloys were prepared by degassing with chlorine, and then obtaining grain refinement by means of the addition of aluminum carbide. Another set of castings, one heat each of the four alloys, were prepared from metal which had been cleaned with No. 310 flux and then superheated.

Two heats of ASTM-4 alloy and one heat each of ASTM-AZ92, A-8, and AZ-91 were also prepared by cleaning the metal with unfused No. 310 flux, thereby producing gassed melts.

Along with the ribbed plates with no risers or risered in various ways, a wedge casting was also poured with each heat to determine the relative melt quality or gas content as measured by the height of sound metal in this wedge casting.

Examination of the ribbed plate by radiography revealed the relative effects of the degree of feeding provided, the alloy composition, and the gas content of the melt. The height of sound metal produced by the degassed melts varied from 1¼ to 3⅜ in. On the other hand, the gassed melts produced ⅛ to ⅞ in. of sound metal in the bottom of the wedge.

Radiographs shown elsewhere[6] are not reproduced here, but the results may be summarized as follows:

1. The degassing treatment, which has produced a considerable increase in the height of sound metal in the wedge casting of all four alloys, decreased only slightly the occurrence of microporosity in the 3/16-in. section of the plate.

2. Castings poured without risers represent the poorest degree of feed-

Table 3

RELATION OF RISER SIZE AND SECTION THICKNESS TO OCCURRENCE OF MICROPOROSITY IN CASTINGS OF FOUR DIFFERENT ALLOYS

	Section Thickness, in.	*Thickness of Risers at Base**, in.* 0	¼	⅜	½	¾	1	1½	2	3
ASTM-AZ63 Alloy	3/16	3	—	3, 4, 0	1	2,0	8,4,2½	4,3	3½	3½
	⅜	0, 0			0,0,3,4½	6½,4,2½	0,0	4,3.6	7½	(10)
	½						7¼,7½,2	—	8*	8
	¾						5½,5	6½,4½,2,6½,6½	—	8
	1								9*,4,1,4½,5½	0
	1½									0,0,1,1
A-8 Alloy	3/16	2½, 3		6, 3½	3	(10,10)	(10,7*,9*)	(10,10)		
	⅜	4, 5		10, 10	0*	(10,10,10,10)	(8*,2,8)	(9*)		
	½	10			2*,2	(10)	(10,10,8*,9*,10)	(10)		
	¾					2	8*,8†	(10,10,10,10)		
	1					0,3½	6½	8*	(10,10)	
	1½					—	0,1½	7½	1, 2	10,0
ASTM-AZ92 Alloy	3/16	10	10	10,10,3½,5,8*,7½*,4	(10)	(10)	(10,10,9*)	(9*)	—	
	⅜	0		(10)	(8½*,10)	(10,8*,10,10,5,10)	(10)	(10)	—	
	½			(10)	(10,8*)	(10)	(10,10,10,10,10,10)	—	—	
	¾				3	3	10,4¼	(8†,10,10,10,10,10,10)	—	
	1					3	3¾	(10,10)	(8†,10,10,10,10,10,10)	
	1½						1	3	2½	2,5,5,10,8,7½†,3½
AZ-91 Alloy	3/16	5, 5	7½*	8*,6½,7*,5,10	(10)	—	(9*,10)	(10)		
	⅜	10, 2	—	(10)	(10,5)	(10,10,10)	(10,10)	(10)		
	½	10	—	(10)	(10)	(10)	(10,10,10)	—		
	¾	—	—		5*	7*	(9*,10)	(5½†,10,10,10)		
	1	—	—			0	3,3	(10,10)	(10,10,10)	
	1½	—	—			—	0	0	1, 4	(10,10,10)

†Microporosity present is the surface type, probably associated with sand reaction and not with shrinkage or dissolved gas.
*Very slight amount of microporosity.
**Riser 6 in. high and ½ in. thicker at the top than at the base.

NOTE: Figures in parenthesis indicate the combination of plate thickness and riser thickness which will produce sound or substantially sound castings of each of the four alloys.

Table 4

Minimum Riser Size Required to Produce Substantially Sound 6x10-in. Plates, Cast Horizontally and Gated, and Risered on One End

	Section Thickness, in.					
Alloy	*3/16*	⅜	½	¾	*1*	*1½*
ASTM-AZ63	*	3	>3	*	*	*
A-8	¾	¾	¾	1½	2	>3
ASTM-AZ92	½	⅜	⅜	1½	1½	>3
AZ-91	½	⅜	⅜	1	1½	3

*Unsound with all riser thicknesses up to 3 in.

ing provided, and those risered at both ends represented the best fed castings. For a specific alloy composition, this range in the degree of feeding provided, however, has produced only a slight decrease in the amount of microporosity obtained in the 3/16-in. sections of the plate, regardless of alloy composition. Thus, risering both ends of the plate has slightly improved the soundness of the 3/16-in. portion of the plate. The ⅜-in. pads, however, must be fed with either a riser or a gate to avoid pronounced amounts of microporosity in this part of the casting.

3. Order of decreasing susceptibility of the alloys to microporosity in this ribbed casting was as follows: ASTM-AZ63, ASTM-AZ92, A-8, and AZ-91, there being a great difference between ASTM-AZ63 and ASTM-AZ92, and only a slight difference among ASTM-AZ92, A-8, and AZ-91. With one 1-in. riser, ASTM-AZ92, A-8, and AZ-91, the 3/16-in. ribbed plates were substantially sound, while ASTM-AZ63 was unsound over its entire area.

4. In this 3/16-in. ribbed plate, the alloy composition is much more important than the gas content of the melt within the considerable range of gas content employed in this portion of the investigation.

Results obtained on the 3/16-in. ribbed plate confirm those obtained on the plain, flat 3/16-in. plate.

Correlation of Theoretical Principles and Experimental Results. All of the foregoing data indicate that the ⅜- and ½-in. sections are not only easier to feed than the 3/16-in., but that they are also easier to feed than the heavier sections. When the section thickness reaches 1½ in., it is quite difficult to obtain sound metal with riser thicknesses twice the plate thickness.

This can be explained by the slow solidification rate in such heavy sections. It is obvious that, if a considerable time is required for solidification, the relatively high conductivity of the alloy will produce very slight temperature gradients toward the risers, producing a long mushy zone.

As indicated previously, the long mushy zone is not conducive to feeding, and the tendency to form microporosity is quite pronounced. On the other hand, the 3/16-in. sections solidify rapidly and almost simultaneously over their entire areas, making progressive solidification toward the riser and adequate feeding difficult.

In other words, under the casting conditions described, the ½-in. section has the optimum cooling rate whereby the most directional solidification toward the risers can take place, producing the shortest mushy zone.

It is clearly evident that ASTM-AZ63 alloy is markedly more susceptible to the formation of microporosity than the other three alloys. The susceptibilities to the formation of microporosity in A-8, ASTM-AZ92, and AZ-91 alloys are of the same order of magnitude, but the susceptibility decreases slightly in the order listed.

Differences in susceptibility to microporosity among the four alloys can be safely attributed to the dissimilarities in composition. The alloy composition determines the solidification range and the amount of eutectic liquid solidifying at the end.

Solidification range of the four alloys is as follows:[5] ASTM-AZ63, 475° F.; ASTM-AZ92, 345° F.; A-8, 315° F., and AZ-91, 300° F.

The amount of eutectic liquid solidifying at the end is indicated by the relative volumes of undissolved beta constituent in the as-cast condition; ASTM-AZ63 alloy has the least amounts of eutectic liquid, A-8 is next, ASTM-AZ92 third, and AZ-91 has the most eutectic liquid or undissolved beta constituent in the as-cast condition.

It is obvious then that ASTM-AZ63 alloy not only has the longest solidification range, but it also produces the least amount of eutectic liquid solidifying at the end. Consequently, this alloy is by far the most susceptible of the four alloys to microporosity.

AZ-91 alloy is less susceptible to microporosity than A-8 alloy because it has a slightly narrower solidification range, but the more important factor is the considerably greater amount of eutectic liquid which solidifies at the end. ASTM-AZ92 alloy has a solidification range markedly less than ASTM-AZ63, but considerably greater than A-8 and AZ-91 alloys.

Because ASTM-AZ92 alloy has a greater solidification range and a lesser amount of eutectic liquid solidifying at the end than has AZ-91, the former is slightly more susceptible to occurrence of microporosity.

On the other hand, ASTM-AZ92 alloy has a greater range of solidification, but the amount of eutectic liquid solidifying is slightly greater than that of A-8. As a result, A-8 is only slightly more susceptible than ASTM-AZ92 to the formation of microporosity.

Liquidus and Solidus Contours

A third factor exists which is not entirely indicated by the consideration of the solidification range and the amount of eutectic liquid as represented by the relative volumes of the beta constituent in the as-cast condition. This factor pertains to the shape of the solidus and liquidus lines.

The shape of the solidus and liquidus surfaces in the complex alloys determines the relative amount of solid and liquid at any given temperature intermediate between the solidus and liquidus (Fig. 5).

If the contour of the solidus and liquidus surfaces is such as to permit a relatively large proportion of liquid to exist to the lower part of the solidification range, the alloy will be less susceptible to the formation of microporosity than if the contour of solidus and liquid surfaces are such as to produce a relatively greater amount of solids in the higher portion of the solidification range.

Examples of these two different types of solidus and liquidus systems are represented by Fig. 5. This third factor is fairly difficult to evaluate. However, it is quite probable that

the contour of the solidus and liquidus surfaces, which would be favorable to the retention of a relatively large proportion of liquid to the bottom of the solidification range, would also be reflected by a relatively large amount of eutectic liquid solidifying at the end. This is illustrated by Fig. 5.

It has already been noted that the proportion of eutectic liquid can be estimated from the relative volume of undissolved beta constituent in the as-cast condition. This third factor, therefore, is not entirely separate from the factor relating to the relative amount of eutectic liquid solidifying at the end of solidification.

In any event, the known facts about the solidification range and the relative amounts of eutectic liquid solidifying explain quite satisfactorily the relative susceptibility of the four different alloys to the formation of microporosity.

Effect of Pouring Temperature. The 6x10-in. plates, 3/16, ½, and 1½ in. thick, were used to determine the effect of pouring temperature on the occurrence of microporosity. These plates of all four alloys were poured over a range from 1500° F. to the lowest temperature at which they could be poured without serious misruns.

In some instances, when an extremely coarse grain was obtained at pouring temperatures near 1250° F., the microporosity appeared to be accentuated; otherwise the pouring temperature had no noticeable effect on the occurrence of microporosity.

This conclusion is somewhat at variance with foundry experience since, under production conditions, it is frequently found that high pouring temperatures produce less microporosity than lower pouring temperatures. Some observations in the laboratory indicated that, when chills were used to produce solidification, the tendency to form microporosity decreased somewhat with increasing pouring temperatures.

Commercial castings, of course, are not always gated into risers, and chills are used frequently to effect progressive solidification toward the risers. Under the conditions of a higher melt temperature in the mold in conjunction with chills and complex sections, it is quite conceivable that there will be sharper temperature gradients increasing toward the risers, which condition will tend to

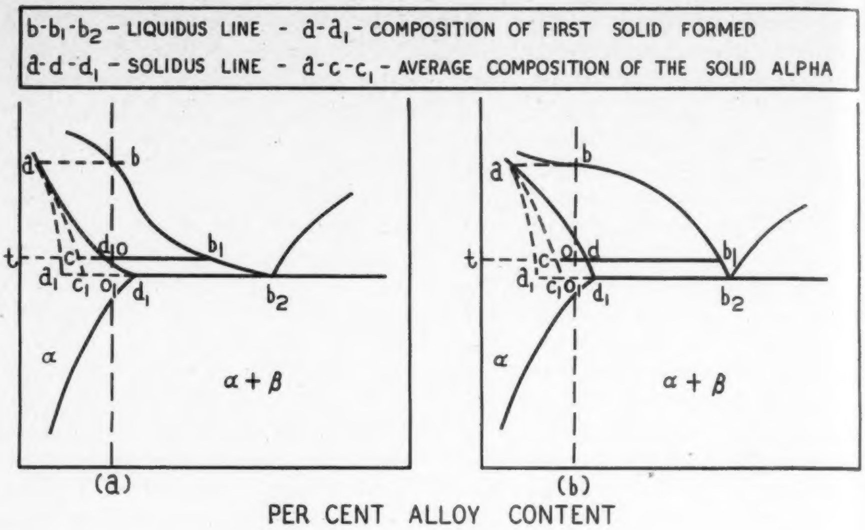


Fig. 5—Intersections of liquidus and solidus surfaces showing two compositions having same solidification range and eutectic temperature, but at temperature (t), system (a) contains 26 per cent liquid while (b) contains only 7 per cent. At the eutectic temperature, (a) contains 13 per cent eutectic liquid, while (b) contains 6 per cent. Alloy (a) will be less susceptible to microporosity because a greater proportion of liquid is retained to lower temperatures. This is also reflected in a greater amount of eutectic liquid and beta constituent, although both have the same maximum solid solubility at the eutectic temperature.

decrease the amount of microporosity formed.

It is to be expected that the experimental plates risered and gated at one end would have a favorable temperature gradient initially, which would not be altered greatly by an increase in melt temperature.

Effect of Mold Material. The wedge casting (Fig. 2) and the 3/16-in. plates (Fig. 3) were prepared in green sand and in a dried sand. The green sand used was a regular synthetic sand containing bentonite for the binder, ethylene glycol, sulphur, and boric acid as inhibitors.

This green sand baked well to produce a dried mold. Accordingly, molds of the same sand were baked at a low temperature to prevent serious loss of inhibitor, but at a sufficiently high temperature to remove the water from the sand.

Approximately six melts of ASTM-AZ63 and ASTM-AZ92 alloys were prepared. One set of molds was poured before fluxing with chlorine, and a second set was poured after fluxing with chlorine. Each set consisted of one green sand 3/16-in. plate, one green sand wedge mold, one dry sand 3/16-in. plate, and one dry sand mold of the wedge.

Careful examination of the plate and wedge castings by radiography showed that the mold materials had no influence upon the amount of microporosity in either the plate or wedge castings. The chlorine flux improved the soundness of both.

These observations indicate that gas is not absorbed by the melt in the mold prior to its solidification. It has been established, for example, that gas will be absorbed by melts of aluminum-base alloys if they are poured into green sand having low permeability.

All sand used in this investigation has high permeability, and it is not to be expected that gas would be absorbed by the melt in the mold. Apparently gas is absorbed by the melt only when the permeability of the sand is sufficiently low to force some of the generated vapor into the liquid melt in the mold cavity.

Summary

Mechanism of the formation of microporosity has been described. The three main factors determining the amount of microporosity are (1) gas content of the melt, (2) alloy composition, and (3) degree of feeding provided. The range of alloy composition investigated was that included by four alloys: ASTM-AZ63, A-8, ASTM-AZ92, and AZ-91.

Range in degree of feeding was

investigated over a range in section thickness including 3/16, ⅜, ½, ¾, 1, and 1½ in., while riser sizes on these sections ranged from zero to 3 in. The relative effects of the three main factors determining microporosity in sections of various thickness may be summarized as shown in Table 5.

If the initial gas content of the melt is very high and the melt is degassed by fluxing it with chlorine, the reduction in microporosity in the light 3/16-in. section will be pronounced. As indicated in Table 5, the decreasing order of susceptibility to microporosity among the four alloys is as follows: ASTM-AZ63, A-8, ASTM-AZ92, and AZ-91. A large difference exists between ASTM-AZ63 and A-8, and only a slight difference exists among the other three alloys.

The ⅜- and ½-in. sections are the easiest to make free from microporosity. Maximum soundness can only be obtained by using (1) degassed melts, (2) alloys least susceptible to the formation of microporosity, and (3) adequate feeding.

Adequate feeding is obtained by the establishment of steep temperature gradients toward the riser or feed head. This is done by the proper use of gates, risers, and chills.

For a given degree of soundness, the ratio of poured weight to casting weight can be reduced by using (1) degassed melts and (2) an alloy in place of ASTM-AZ63 having less susceptibility to the formation of microporosity.

Pouring temperature had little or no effect upon the amount of microporosity formed in these test castings, which were 6x10-in. plates cast horizontally with gate and riser on one end only. If, however, chills were used in the mold and if the gates did not enter the risers, it is quite likely that the microporosity may decrease somewhat with increasing pouring temperature.

It was also found that the amount of microporosity formed was approximately the same in dried molds as in green sand molds, indicating that gas is not absorbed by the melt in the mold cavity.

Table 5

RELATIVE EFFECTS OF FACTORS DETERMINING MICROPOROSITY

Factor	*Effect on Microporosity for Section Thickness, in.* 3/16	⅜ to ½	1 to 1½
Decreasing gas content	Slight Decrease	Marked Decrease	Marked Decrease
Increasing riser size within normal limits	Slight Decrease	Marked Decrease	Marked Decrease
Changing alloy composition from ASTM-AZ63 to A-8, ASTM-AZ92, or AZ-91	Marked Decrease	Marked Decrease	Marked Decrease

Acknowledgment

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A. F. A. To Register "Old Timers" In '46

MEMBERS WHO ATTENDED the 1940 Convention in Chicago and the 1942 meeting in Cleveland will recall that the registration of "Old Timers" was a most interesting phase of those Foundry Weeks. Nothing could be more appropriate than to continue this recognition of men who have long served in the foundry industry, during the 50th Anniversary Convention in Cleveland, May 6-10.

The "Old Timers" booth will be set up in the Official Headquarters booth of A.F.A., located in the Arena exhibit hall just off Registration Lobby. Here those who have served 50 years in the castings industry will be welcomed, registered and given a special "50 Years of Service" emblem and badge. The same procedure will be followed with foundrymen who have served in the industry 25 years or more.

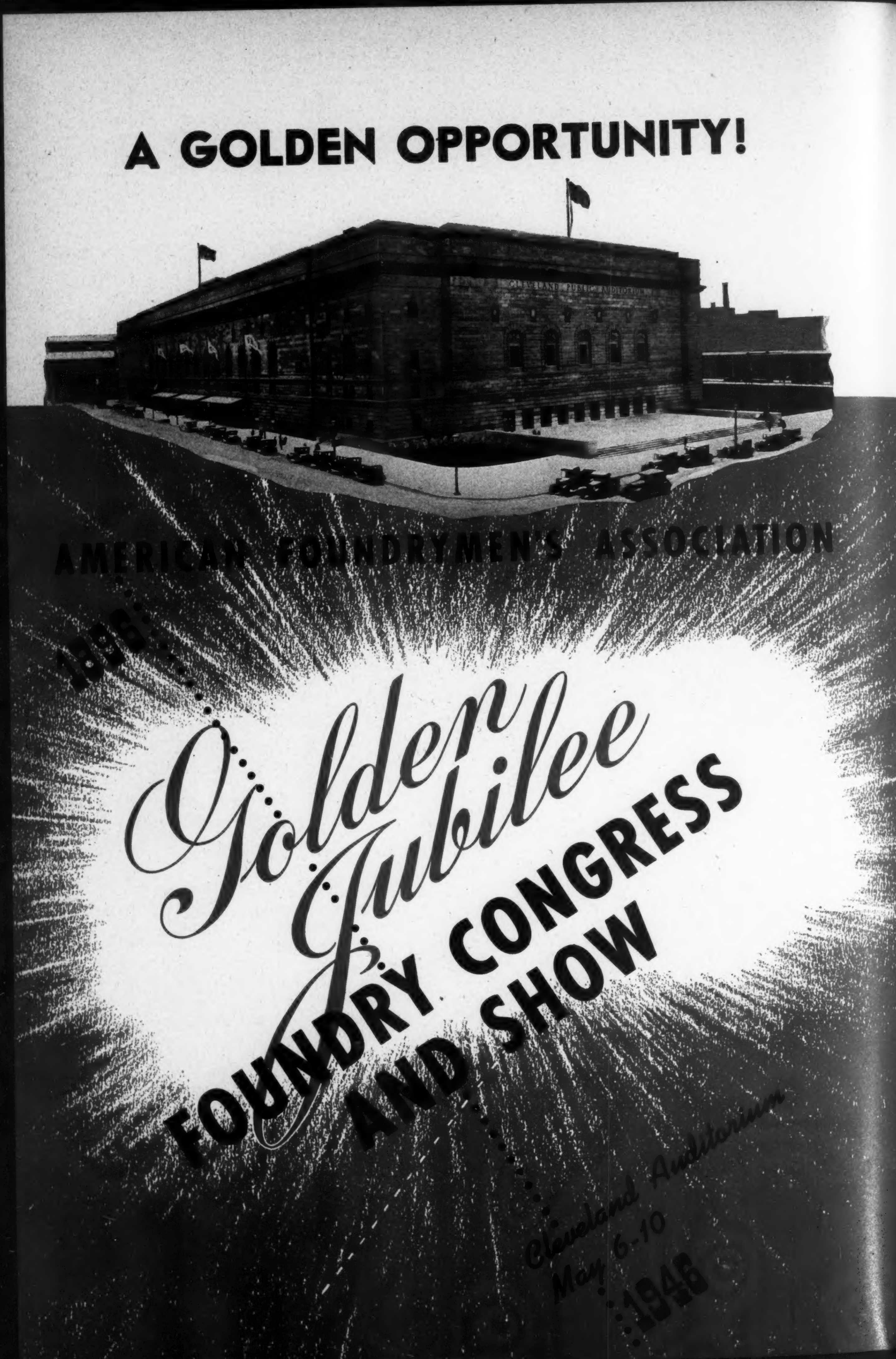
The Association is particularly anxious to welcome men who attended the early conventions of A.F.A. prior to 1910, and special recognition will be given all such men who register at the convention. Thus far only two or three men have been located who were present at the first convention of the American Foundrymen's Association at Philadelphia in 1896, but it is hoped others will be on hand at Cleveland.

Lecture Sessions Will Feature Modern Control

THE ANNUAL LECTURE COURSE, an important event of A.F.A. annual meetings since establishment in 1943, will be continued at the 50th Anniversary Foundry Congress in Cleveland, and this year will be presented in five sessions. Sponsored by the Annual Lecture Committee, under the chairmanship of H. M. St. John, Crane Co., Chicago, the 1946 course will deal with the general and important subject of "Foundry Control."

One session will be presented each day of the week, all scheduled at 4:00 p. m., starting on Monday, May 6, with Aluminum and Magnesium Foundry Control. Discussion at this lead-off meeting will be conducted by Oscar Blohm, Hills-McCanna Co., Chicago.

An A.F.A. Gold Medallist, Carl F. Joseph, Saginaw Malleable Div. of General Motors Corp., Saginaw,


A GOLDEN OPPORTUNITY!
CLEVELAND PUBLIC AUDITORIUM
AMERICAN FOUNDRYMEN'S ASSOCIATION
1896
Golden Jubilee
FOUNDRY CONGRESS AND SHOW
Cleveland Auditorium
May 6-10
1946

Mich., has agreed to act as discussion leader of the Tuesday lecture period. The subject that day deals with Malleable Foundry Control. Brass and Bronze Foundry Control will be considered Wednesday afternoon, and the Chairman of the Brass and Bronze Division, D. Frank O'Connor, American Saw Mill Machinery Co., Hackettstown, N. J., is scheduled as the discussion leader.

Session No. 4 of the lecture course will deal with Steel Foundry Control, a subject to be offered Thursday afternoon. G. A. Lillieqvist, American Steel Foundries, East Chicago, Ind., will lead the discussion. Winding up the lecture series for 1946, Gray Iron Foundry Control will be covered on Friday. W. A. Hambley of Allis-Chalmers Mfg. Co., Milwaukee, and one of the most active A.F.A. members at this convention, will act as the discussion leader.

Typical of the manner in which A.F.A. committee work is conducted in the interest of the membership is the account of how "Foundry Control" was made the subject of this year's lecture course. Several inquiries about control methods reached the National office of A.F.A. last Spring, and the question of a convention session on the subject was broached tentatively at several informal luncheons.

The response indicating the need for more up-to-date information, letters were sent to several well-known foundrymen whose replies heartily endorsed the idea. Thereupon the Annual Lecture Committee was approached, the subject being of interest to all A.F.A. Divisions, and their approval and organization of a lecture course for 1946 followed.

So. California Lecture Material Is Published

WITH COMPLETION of a lecture course considered outstandingly successful, the Southern California A.F.A. chapter has made the text of the technical papers presented available in book form under the title, *Casting Production,* Chapter President R. R. Haley, Advance Aluminum & Brass Co., Los Angeles, has announced.

Among the authorities who participated in the educational project were: F. G. Sefing, International Nickel Co., New York; N. J. Dunbeck, Eastern Clay Products Inc., Eifort, Ohio; and C. B. Schureman, F. E. Schundler & Co. Inc., Joliet, Ill.

Mr. Sefing, Chairman of the Executive Committee, A.F.A. Committee on Cooperation with Engineering Schools, presented a discussion of "Gating and Risering Practice." Mr. Dunbeck, member of the Nomenclature and Grading and Fineness committees, A.F.A. Foundry Sand Research Project, prepared a paper on "Molds and Cores Material," which is included in the book.

Delivers Added Lecture

However, when Mr. Dunbeck was forced to cancel his trip to the coast, Mr. Schureman, who also has been active in the foundry sand project, delivered a lecture on the subject. Unfortunately, publication deadline made it impossible to include Mr. Schureman's remarks.

Subjects and authors of other papers which appear in the book are: "Specifications," E. K. Smith, metallurgical consultant, Beverly Hills, Calif.; "Patterns," J. A. Burgard, Columbia Steel Corp., Los Angeles; "Inspection and Repairs," E. G. Smyth, Standard Oil Co. of California, Los Angeles; and C. E. Lloyd, Shipbuilding Div., Consolidated Steel Corp., San Pedro, Calif.

Handle Arrangements

Chapter members active in arrangements for the course include: Executive Chairman J. E. Wilson, Climax Molybdenum Co., Los Angeles; Robert Gregg, Reliance Regulator Co., Los Angeles; A. G. Zima, International Nickel Co., Los Angeles; Chapter President R. R. Haley; and Chapter Director W. D. Bailey, Jr., Westlectric Castings, Inc., Los Angeles.

Committee chairmen were: *Papers,* Robert Gregg; *Publicity and Publication,* W. D. Bailey, Jr.; *Finance,* G. V. Ballard, Federated Metals Div., American Smelting & Refining Co., Los Angeles; and, *House Committee,* P. E. Crow, Equipment Engineering Co., Los Angeles.

Sessions chairmen for the lectures were: E. F. Green, Axelson Mfg. Co., Los Angeles; Earl Shomaker, Kay Brunner Steel Products Co., Alhambra, Calif.; Chapter Treasurer L. O. Hofstetter, Brumley-Donaldson Co., Los Angeles; Chapter Vice-President B. G. Emmett, Los Angeles Steel Castings Co., Los Angeles; and J. B. Morey, International Nickel Co.

Members Aid National Apprentice Contest

PATTERNS, core boxes and blueprints for the A.F.A. National Apprentice Contest were furnished through the cooperation of A.F.A. members.

Blueprints for the patternmaking division of the contest were supplied by C. W. Wade, Caterpillar Tractor Co., Peoria, Ill., and Frank Cech, Cleveland Trade School, Cleveland.

Peter Rettig, Rettig Pattern Co., Cleveland, and L. F. Tucker, City Pattern Works, South Bend, Ind., provided the patterns for the nonferrous molding division.

Four patterns used in the gray iron and steel molding divisions were furnished by J. G. Goldie, Cleveland Trade School; V. J. Sedlon, Master Pattern Co., Cleveland; John E. Gill, Lake Shore Pattern Works, Erie, Pa.; and H. K. Swanson, Model & Pattern Works, East Chicago, Ind.

Now in its final stages, the 50th A.F.A. Anniversary Contest has attracted many new companies not represented in past years. Companies which have entered contestants annually for almost 20 years are sponsoring entries in the competition for prizes in the Golden Jubilee Convention year.

Deadline Near

Contestants are molding and pouring castings, and completing patterns, to meet the April 27 deadline. Identified by special tags supplied by the A.F.A. National Office, entries must be received by J. G. Goldie, Cleveland Trade School, 535 Eagle Ave., Cleveland, Ohio, not later than April 27 to be eligible for judging.

Entries in the 1946 A.F.A. National Apprentice Contest can be seen at the 50th Anniversary Convention, May 6-10. Also displayed will be patterns entered in the A.F.A. apprentice contest during the past 10 years and an exhibit by the Cleveland Trade School.

50 YEARS OF PROGRESS IN FOUNDRY

SAND CONTROL

R. F. Harrington
Foundry Superintendent
Hunt-Spiller Mfg. Corp.
Boston

THE FIRST ARTICLE on the subject of molding sands ever presented before an A.F.A. audience seems to have been a paper by Thomas D. West in 1896. This paper was general in nature but apparently brought forth considerable discussion at that first meeting of the American Foundrymen's Association, fifty years ago.

In 1897, another author, writing on the subject of molding sands, lists four properties: Refractoriness (by chemical analysis), Porosity, Fineness, and Bond. No test, however, was suggested by this writer, D. H. Tuesdale, except the old hand test.

A third article, in *The Foundry,* written by W. J. Keep at this time, appears also to be one of the earliest papers on molding sands. It covered a report on a sample of sand received by Mr. Keep for his examination and comment. The great lengths to which Mr. Keep had to go in describing the sand properties is much in contrast to the type of report that would be forthcoming today from a consultant who would have all the advantages of standardized test results to aid him in his analysis of properties.

First Hardness Testing

The J. I. Case Threshing Machine Co., in 1900, seems to have been one of the first companies to set up sand specifications. In 1903, Thomas West again described, in a paper on sand testing, what appears to be one of the first machines for the testing of the hardness of ramming. Except for the reference to a test machine as desbribed by West, it would seem that the early foundryman concerned himself primarily with a study of the new sands as they affected the properties of the foundry heap sand or facing.

During the next ten years investigators, through laboratory tests, continued their efforts to learn more about characteristics of molding sands. The paper by Dr. H. Ries in 1906, entitled *"Laboratory Examination of Molding Sands,"* appears to be about the most complete article then available from the technical standpoint on sand grain shape and size. About this time, too, Le Chatelier and Vinsonneau described tests on grain size, resistance to mechanical crushing, and permeability.

In 1912 the American Foundrymen's Association sponsored a study of molding sands and Dr. Richard Moldenke, then Secretary of the American Foundrymen's Association, was directed to appoint a committee that would function under his guidance. Over 92 sands were studied by Dr. Moldenke and his committee, the physical tests employed covering fineness, transverse strength, permeability, and clay bond strength through the use of the dye absorption test, employing an analine dye known as malachite green.

This chronological report of a half century of development in the field of sand control emphasizes the constantly growing importance given this subject by cast metals producers. It brings out, too, the work of A.F.A. in this field, especially through its Committees on Foundry Sand Research. The author long has been active in this phase of Association activity.

Sand Testing Taught

With the publication of the work of the above committee, the testing of molding sands became more common. Wentworth Institute, Boston, had already introduced the testing of molding sands into their foundry course, using many of the tests described above as well as those developed by the institute for determining the permeability of molds under varying pressure. During the latter part of this period, continued interest was shown in sand testing, with more thought given to other means of measuring the strength than by the transverse test familiar to earlier workers. Thoughts also were beginning to turn to the reclaiming of both core and molding sands.

During the twenty years from 1897 to about 1916 saw little actual work on sand control, although there was increasing evidence of the important part that selection of the proper molding sand played in foundry production, both as to quality of castings and tons of castings produced per ton of new sand. While mention of the earlier investigators has thus far been made, the limited scope of this article will prevent further specific reference to

individuals, except in unusual cases.

The years between 1916 and 1925 were some of the most active in sand research and sand control. A most important development occurred in 1921 when A.F.A. accepted an invitation to join with the National Research Council to jointly sponsor a study of molding sand testing and control. On accepting this invitation a joint committee was organized, with the late R. A. Bull, past President of A.F.A., as Chairman. A large number of A.F.A. members, pioneers in sand research, accepted membership on the Committee and a program advanced by the National Research Council was adopted.

The first project involved preparation of a complete bibliography of all published literature on the subject. This material was studied and correlated and a research program formulated so as to fill in and obtain further necessary data. The bibliography was furnished by the National Research Council and A.F.A. reviewed and correlated all articles therein. Since the National Research Council's function was strictly organizational, the Council presently withdrew and the work has been carried on ever since as an A.F.A. committee project.

The correlation, issued late in 1921, furnished the basis for the work of the Joint Committee on Molding Sand Research, which developed practical methods of testing various physical properties of sands such as moisture content, strength, permeability, fineness and methods of chemical analysis.

In June, 1921, the committee published its first edition of the book, "Methods of Testing Molding Sands." This Committee continued its work and from time to time revised and amplified its book, the 2nd edition of which was published in 1928; the 3rd edition in 1931; the 4th in 1938; the 5th (current) edition having been issued in 1944.

Up to 1921 few workers had developed methods for testing sand properties, but in general the methods lacked accuracy and results were not comparative between one investigator and another, due to lack of standardized equipment and methods. The sand committee's first work concerned itself with the following properties which were considered to be the most important: (1) Moisture Content, (2) Permeability, (3) Strength, (4) Fineness, (5) Refractoriness, and (6) Durability or life.

During the latter part of this period due partly to the added knowledge on sand testing and the contributions to the literature by those already using sand control, considerable progress was made in this direction. Sand reclamation and conservation also was beginning to develop more rapidly, principally through the use of various types of clay bond, especially selected new sands carrying a high colloidal clay content, and broadening recognition of the value of more intensive mixing, as a means both of conservation and of sand control.

About this time the introduction of a mold hardness tester, fashioned somewhat after the principle of a Brinell meter, added greatly to our knowledge of mold hardness variables and their effect on the quality of the casting produced.

Control Greatly Expanded

During the period 1926 to 1935, the foundry industry greatly extended its use of sand control. New tests were constantly being developed by individual investigators or through the efforts of the Joint Committee on Foundry Sand Research. Particular mention shall be made of the various devices for measuring mold permeability and the thought given to means of determining the sea coal content of heap sand.

Methods for grading of molding sands were undertaken by the Joint Committee and ultimately a standard was set up which gave the user another tool with a more effective selection of the most desirable sand for a given purpose. One paper, presented before A.F.A. in 1927 by J. M. Haley and entitled "An Analysis of Four Hundred Tons of Defective Castings," pays splendid tribute to the value of sand control as a means of reducing defective castings.

In 1928 two very complete papers on sand control methods were presented, indicating the extent to which sand control had broadened in scope, the following tests being used both for control and investigation: Tensile strength, green sand strength, permeability, moisture, grade, durability, relative fusion point, and microscopic examination. The problem of hot versus cold permeability was receiving the attention of a number of investigators both in industry and in our research laboratories.

Actual mold conditions also were being studied as affected by variables in jolting or squeezing operations. One author, on light steel casting practice, expressed it as his opinion that ninety-five per cent of the defects which he had investigated were due to some mold deficiency. Mold density, as affecting trueness to pattern and soundness of casting, was also receiving more and more attention.

Sand Producers Active

Our sand producers, always cooperative, were rapidly taking recognition of the value of sand control, and foundrymen large and small were being benefited by more uniform shipments of sand conforming more nearly to the specified requirements of the user. A brief report at this time by the Technical Director on A.F.A. Sand Research advised the industry of the great interest in sand testing and control, stating that when the new (3d) edition of the A.F.A. Sand Testing Book was announced, over 1,700 requests for the publication were immediately received.

The years 1930 through 1935 saw many advances in sand control, in both large and small foundries. One large malleable foundry operating a continuous molding unit reported that moisture, permeability and bond tests were being run every hour. Another light gray iron foundry was carrying on an extensive series of tests on sand and mold control, as affecting casting surface. Several investigators were also working on the problem of sand flowability and its effect on mold characteristics. The last year of the period 1926-1935 saw considerable attention being devoted to tests involving expansion and contraction characteristics at high temperatures.

The years 1936, 1937 and 1938 brought new terms to our foundry vocabulary—for example, deformation and resilience, properties which were to become more and more important in molding sand work. A very interesting report covering the

details of sand practice in the foundries of seven automobile companies and representing over 6,000 tons capacity daily, indicated the tremendous strides that had been made not only in sand control but also in the use of clay bonded or synthetic sand. The report covered the modern methods being employed in the production and control of sand for the most important types of castings. In addition to the usual tests for permeability, green strength and moisture, daily tests were given for dry strength, deformation and flowability. Mold hardness control, as a daily routine, was strongly advocated.

A.F.A. Sand Books Published

The report of the A.F.A. Committees on Sand Research and Sand Testing advised (1938) of completion of the 4th edition of *Testing and Grading Methods for Foundry Sands,* the first edition to include testing methods for foundry clay.

The years 1939 and 1940 were ones of consolidation in respect to sand testing and control. Attention was directed to the problem of controlling the physical properties of sand, as affected by rapid re-use and consequently involving short cooling periods in mechanical units. Rapid drying out of synthetic sands and the use of various wetting agencies as an aid in controlling moistures, was likewise receiving a great deal of thought. A paper on "The Influence of the Mold on Shrinkage in Ferrous Castings," which was presented during this period, indicated very forcefully the further need of controlling those factors affecting the conditions of the mold.

Contrasting greatly with the simple tests believed necessary in the earlier periods, one author, in a paper on synthetic sands presented in 1941, remarked: "In any molding sand, we are interested principally in (1) grain size, (2) green strength, (3) dry strength, (4) hot strength, (5) permeability, (6) durability, (7) flowability, (8) moisture required, (9) resilience, (10) expansion, (11) contraction, and (12) sintering point."

Another company, operating a number of foundries throughout the country, reported on the importance of sand control in relation to the reduction in defective castings and the need for careful correlation of foundry defects with molding sand control data in order to achieve better control of foundry defects.

The year 1942 brought to the foundrymen another paper on the drying out of synthetic sands and the use of fuel oil as a retarding agent. A paper at this time on the subject of sea coal and fuel oil was presented with suggestions for the means of control of the former in the heap.

Present Interest High

In 1944, we had two papers before the A.F.A. devoted to high temperature studies—one entitled "Mold Surface Properties at Elevated Temperatures," the other "Mold Atmosphere Control." In this year and the following, sand control continued to increase in scope and usefulness.

During this period, because of the importance and extent of work on molds at elevated temperatures, the sub-committee on this phase of testing was elevated to full committee status and was designated "Committee on Physical Properties of Foundry Sand at Elevated Temperatures."

In concluding this review, covering fifty years progress in sand control, the important part played by the Joint Committee on Molding Sand Research in the development of sand control, is impressive. Industry owes a debt of gratitude to the various chairmen, including Major Robert A. Bull, Walter M. Saunders, Benjamin D. Fuller, Fred Erb, and the present chairman and technical director, Dr. H. Ries. Likewise, industry is indebted to the technical secretaries of this committee, to the many sub-chairmen, committee members, and those countless workers in laboratory, plant and technical institutions who have so generously given of their time and effort to the subject of sand control and the development of the many tests which have made sand control possible and have demonstrated its value.

The author wishes to acknowledge his indebtedness to Secretary Emeritus R. E. Kennedy in the loan of material, helpful in the preparation of this article.

WANTED!

Men who attended A.F.A. Conventions of 1896, 1897, 1898 and 1899.

If you are one of these "earliest of "Old Timers" . . . or if you know of any man, now living and in the industry, who attended those conventions . . . **please send their names and addresses promptly** to the Secretary, American Foundrymen's Association, 222 W. Adams St., Chicago 6.

The Association desires to extend a special invitation, on the occasion of the 50th Anniversary Convention and Exhibit in Cleveland, May 6-10, to those who were active in organizing and cooperating with the Association in its early days preceding 1900. The cooperation of all members to this end will be appreciated.

Cupola Handbook Is Now Being Printed

THE PUBLICATION of the Cupola Research Project, THE CUPOLA HANDBOOK, now is in the hands of the printer with a promise that copies of the book will be available at the time of the 50th Anniversary Convention in Cleveland, May 6-10.

The book will contain nearly 500 pages, with scores of illustrations and tables, and undoubtedly will prove to be the most useful and most complete book ever published dealing with cupola operations. The work of over 100 outstanding gray iron metallurgists and practical foundrymen who contributed to its contents over the past five years, its usefulness to iron foundrymen is already assured.

Commenting on one or two chapters submitted for review, several foundry executives and well known metallurgists have declared the CUPOLA HANDBOOK to be "intensely practical, and of outstanding importance to the gray iron industry."

Announcement will be made about convention time when the book is available to A.F.A. members, and the price per copy is being kept at a minimum figure commensurate with publication costs in order that the book may be utilized by the greatest number of foundrymen.

Copies will be available for display and orders during the Convention at the A.F.A. Headquarters Booth located in the Arena Exhibit Hall.

STEEL SUSCEPTIBILITY TO HOT-TEAR FORMATION IN CASTINGS

A contribution to the subject of hot-tear formation in low carbon steel castings. One possible cause may be the allotropic transformation of delta phase into gamma phase in steel.

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In any discussion of hot-tear formation in steel castings, the question of the susceptibility of various steels to hot tearing always arises, as pointed out by Briggs* (1943).

Original investigation and observation data indicate that:

(a) Various steels under the same conditions and depending upon these conditions are quite different in their susceptibility to hot-tear formation.

(b) The tendency to hot-tear formation is essentially influenced by the allotropic transformation of delta phase into gamma phase, that takes place in most kinds of steel during the cooling of castings.

The influence of this transformation will be clear if the following points are considered as the basis of the theory of hot-tear formation:

Hot tears are formed in most cases due to the hindered contraction of the metal during cooling.

Factors which are responsible for hindered contraction may be divided, in most cases, into two groups—internal and external.

(a) The hindrance caused by the mold, i.e., by the material of the mold, cores, cross-bars of the flasks, etc. For identification, this type of hindrances will be termed "external hindrances."

(b) The hindrances which appear due to the temperature gradient produced between the adjoining parts of a casting of various cross sections. In many cases, these temperature gradients reach a high degree in the cooling process. This type of hindrances will be termed "internal hindrances."

Both types of hindrances mentioned above can exist in a casting, either separately or together. To avoid confusion, other factors which may play a part in hot-tear formation have not been discussed in this paper.

Carbon Steel

Plain carbon steel immediately after complete solidification (just below the solidus) produces either:

(a) Solid solution of carbon in delta iron (in carbon steel, which contains carbon up to the limit of point *H* of the peritectic line *HIB* in the iron-carbon constitutional diagram) or:

(b) A mixture of solid solution of carbon in gamma iron and of solid solution of carbon in delta iron (in carbon steel, which contains carbon within the limits of points *H* and *I* of the peritectic line, called low carbon steel), or:

(c) Solid solution of carbon in gamma iron (in carbon steel with the carbon content above the limit of the peritectic point *I*).

Out of the latter kinds of steel must be distinguished the types in which paritectic reactions exist (in carbon steel with carbon content within the limits of points *I* and *B* of the peritectic line, further called by agreement medium carbon steel).

In this connection, the usual division of contraction into an "above pearlite" point and "below pearlite" point must be considered insufficient. The contraction must be divided into three stages:

(a) Contraction in the region of delta phase.

(b) Contraction in the region of gamma phase.

(c) Contraction in the region of alpha phase.

Hot-tear formation is greatly affected by a sharp change of the coefficient and the rate of contraction at the moment of the allotropic transformation of the first two phases (the transformation of delta phase into gamma phase) inasmuch as the mechanical properties of steel are known to be quite low at these temperatures.

It must be considered that this transformation accompanies a contraction in volume. Therefore, the temperature of this transformation can be considered "the main critical temperature" of hot-tear formation.

The transformation of gamma phase into alpha phase plays a secondary role (especially for carbon steel) because by that time the mechanical properties of steel significantly improve.

External Hindrances. If only external hindrances to normal contraction of the metal are present, hot tears appear as a result of failure of the metal at such high temperatures at which the cohesion between crystal grains became weaker than the grains themselves.

In such cases, the low carbon steel

*C. W. Briggs, "Hot-Tear Formation in Steel Castings," Transactions, American Foundrymen's Association, vol. 51, pp. 57-85 (1943).

This paper will be presented and discussed at a Steel Castings Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 6-10, 1946. Oral and written discussion is solicited.

is less susceptible to hot-tear formation than the medium carbon steel. This is explained by the fact that the improvement of the mechanical properties of the crystals and of the cohesive force between them at the falling temperature near the solidification temperature is at a greater rate in the low carbon steel than in the medium carbon steel.

It is important to note that, in the low carbon steel, with the increase of carbon content up to the limit of the peritectic point better results are obtained. This can be explained by the fact that with the increase of carbon content in this kind of steel the temperature of the allotropic transformation of delta phase into gamma phase is comparatively higher.

The total contraction of metal in this case in the region of delta phase (when the mechanical properties of the metal are very low) is insignificant and, consequently, the danger of metal failure at the temperatures of this region is smaller.

Coefficient Change

Change of the coefficient and of the rate of contraction produced at the transformation of delta phase into the gamma phase is also not so harmful due to the fact that the improvement of the mechanical properties of low carbon steel after complete solidification begins sooner with the increase of carbon content. This refers especially to the toughness of metal due to the presence of gamma crystals.

Furthermore, by the time transformation occurs mold material has not yet been heated to such high temperatures and the hindrances to normal contraction reach dangerous magnitudes (in the cases when such types of hindrances exist).

Alloying elements eliminate the tendency of steel to hot-tear formation caused by external hindrances to normal contraction of metal if they effect the following:

(a) Increase at high temperatures the cohesive force between the crystal grains of the metal.

(b) Produce immediately after complete solidification solid solutions by means of which the strength and plasticity of the crystals improve.

(c) Do not produce new structural constituents, brittle at high temperatures, deposited at the grain boundaries.

More favorable alloying elements of those mentioned in the foregoing are those which widen the gamma region at the expense of narrowing the delta region, both in temperature and concentration directions.

Alloying elements narrowing the gamma region are less favorable than those widening the gamma region, even if they are added in such quantities that the gamma region entirely disappears and, in this case, the polymorphic change is absent.

Crystals Lower

This is explained by the fact that the toughness of crystals in alpha state is lower than that in the gamma state, and that here the cohesive force between the grains is realized more clearly.

Internal Hindrances. If only internal hindrances to normal contraction of metal are present, hot tears appear because thin parts of a casting tear off from the thick parts. In the case of plain low carbon steel, the temperature of the thin parts of the casting may drop during the cooling cycle to such values that the allotropic transformation of delta-gamma phases within them will end, while in the thick parts of the casting this transformation has not yet started. In consequence, the coefficient and the rate of contraction of the thin parts sharply increase, and the tendency to "tear off" from the thicker parts increases.

As at the same time the mechanical properties of metal of the thin parts of a casting which are affected by the allotropic transformation in the region of gamma phase are better than those of the thicker parts which are still in the region of delta phase, hot tears appear in the thick parts, i.e., in the weakest parts of a casting, as previously mentioned.

Gamma Phase

In the case of the medium carbon steel, all parts of a casting (thin as well as thick) just below the solidification point are in the region of gamma phase. In this case, the tendency of thin parts to tear off from the thicker parts is eliminated because both parts have the same structural constituent, and the sharp changes of physical properties which exist at the temperatures of the polymorphic transformation are absent.

Consequently, if only internal hindrances to the normal contraction of metal are present, the medium carbon steel is less susceptible to hot-tear formation than is the low carbon steel. The influence of carbon content in both kinds of steel upon hot-tear formation affected by internal hindrances to the normal contraction of metal has not been completely investigated as yet.

However, it may be supposed that the increase of carbon content in the low carbon steel will play a favorable part due to the increasing temperature of the allotropic transformation of delta-gamma phases.

Therefore, with the increase of carbon content in the low carbon steel the temperature difference between the thin and the thick parts of a casting at the beginning of the allotropic transformation of delta-gamma phases is quite small and, consequently, the tendency of thin parts to tear off from thicker parts is inconsiderable.

Alloying Elements

Proceeding from incomplete data on the influence of alloying elements upon hot-tear formation when only internal hindrances to normal contraction of metal are present, a conclusion can be reached that the alloying elements which widen the region of the gamma phase at the expense of the region of the delta phase, both in the temperature and in the concentration directions, are favorable, especially if they improve the mechanical properties of metal.

Alloying elements which narrow the region of the gamma phase have, in this case, a smaller but still favorable influence upon the elimination of the tendency of steel to hot-tear formation. But this can occur when these elements are added in such quantities that the gamma region vanishes completely, and thus the steel is transferred into a range where the allotropic transformation at high temperatures is absent.

It may be supposed that the elements which raise the temperature of the allotropic transformation of delta-gamma phase will also be favorable.

Internal and External Hindrances, and Other Factors. If both types of hindrances to normal contraction of the metal exist, the influence of carbon content and of alloying elements upon the susceptibility of steel to hot-tear formation depends upon the combination of these hindrances. However, under all of these circum-

stances the better steel is that which:

(*a*) Has no transformation of delta-gamma phases.

(*b*) Improves the mechanical properties of steel soon after complete solidification.

(*c*) Produces gamma solid solution immediately after complete solidification.

(*d*) Has no chemical compounds, deposited at the grain boundaries, which are brittle at high temperatures.

(*e*) Has no low fusible chemical compounds, at grain boundaries.

Little doubt exists that alloying elements, with regard to susceptibility of steel to hot-tear formations, in all cases have considerable influence upon heat conductivity and fluidity of the metal, diffusion processes existing during solidification, coefficient of contraction, and other properties. This influence is a subject for further research.

Discussion

C. H. LORIG[1] *(written discussion):* Mr. Gelperin, in suggesting as one possible cause for hot tears in low-carbon steel castings the allotropic transformation of delta phase into gamma phase, has made an interesting contribution to the subject of hot-tear formation. According to the iron-carbon constitution diagram, those steels with less than about 0.18 per cent of carbon will contain delta iron immediately after solidification and would, by the reasoning of Mr. Gelperin, be susceptible to hot tearing as a result of allotropic transformation. The steels of higher carbon content would contain no delta phase by the time they have completely solidified, and hence other causes for hot tearing would necessarily be operative on such steels.

Because the delta to gamma transformation results in a contraction in volume, it is not difficult to visualize its importance in promoting hot tears in the low-carbon steel castings, especially since such steels contain phosphorus and sulphur which may form constituents that exist in the vicinity of grain boundaries of lower melting temperature than the bulk of the steel.

On the basis of Mr. Gelperin's suggestion, it is reasonable to expect that the hot-tear propensity diminishes, perhaps sharply, in going from compositions in which the delta phase exists in the solid to those in which the phase is nonexistent. This is provided that the longer freezing range for the latter compositions, or some other factor, does not compensate for the disappearance of the transformation effect. Foundries may have noted such a change in hot-tear propensities with change in carbon content, but have not attempted an explanation. On the other hand, the matter may not have had much consideration, since the bulk of the steel cast is of a carbon content outside the range for the existence of the delta phase in the solid, and few foundries have had experience with low-carbon melts. In view of the absence of any supporting data in Mr. Gelperin's paper, in the interest of a fuller understanding of causes for hot tears, it would seem desirable that the importance of the delta-gamma allotropic transformation with respect to hot-tear formation be appraised by some one.

[1]Metallurgist, Battelle Memorial Institute, Columbus, Ohio.

C. W. BRIGGS[2] *(written discussion):* Mr. Gelperin presents an interesting discussion on hot-tear formation, especially from the point of view that the allotropic transformation of delta phase to gamma phase is important in effecting sharp changes in the coefficient and rate of contraction of steel, and thereby influencing the hot-tear formation in steel castings. The author, however, does not justify his position with the presentation of data. It is understood by the writer that the collection of such data is decidedly not an easy matter. This is most certainly true of any study involving temperatures close to the solidification temperature of steel. However, such quantitative data are necessary to evaluate completely the suggestions which the author has put forth in his paper.

Studies by Driesen[1] for ingot iron indicate that there is a change in the coefficient and rate of contraction at a temperature of about 2555° F. This is because of the pronounced change from the delta phase to the gamma phase. For low carbon steels of 0.10 to 0.18 per cent carbon, the transformation that takes place is between a mixture of delta plus gamma phase and gamma phase. This transformation apparently does not produce a pronounced change in contraction; at least Briggs and Gezelius,[2] in studies of the free and hindered contraction of carbon steel, were unable to record any contraction differences between the two steels (0.08 and 0.15 per cent carbon), which solidified as a mixture of delta plus gamma, and the other four steels which solidified as the gamma phase.

In view of the fact that the author stated that the temperature of the transformation of delta plus gamma to gamma phase was the "main critical temperature" of hot-tear formation of low carbon steels, the writer wondered what the author would consider as the critical temperature of hot-tear formation of medium carbon steels? It is believed that the manner of selecting the critical hot-tear temperatures as set forth by Hall[3] and Briggs[4] is the more preferable.

[2]Technical Research Director, Steel Founders' Society of America, Cleveland.

Briggs' References

1. J. Driesen, *Ferrum,* 1913-14, vol. 11, p. 129.
2. C. W. Briggs and R. Gezelius, TRANSACTIONS, American Foundrymen's Association, vol. 42, pp. 449-470 (1935).
3. H. Hall, Iron and Steel Institute Special Report 15, 1935, pp. 63-94.
4. C. W. Briggs, TRANSACTIONS, American Foundrymen's Association, vol. 51, pp. 57-85 (1943).

Aircraft Castings Made Available For Schools

EDUCATIONAL GROUPS of A.F.A. Chapters can help educational institutions in their area secure aeronautical castings or an entire plane for use in technical training.

From the War Assets Corp. educational institutions may acquire cast aircraft parts, engines, other aeronautical property, or even an entire plane, at disposal cost. Disposal costs range from about $100 for a basic trainer to approximately $350 for the largest bomber. The only additional cost is for transportation of the parts.

Cast parts of all types, such as cylinder heads, supercharger housings, brackets, levers, wheel assemblies, etc., are valuable teaching aids for foundry instructors. Illustrating cast metal of all types in a variety of applications, they can also be used for exhibits in school libraries, museums, and at student organization meetings. Strength, lightness, dependability, resistance to shock or repeated stress, and good casting design are represented in aircraft castings manufactured to ordnance specifications.

Foundry departments of educational institutions can make other uses of plane parts and accessories. Disassembled cast parts of a plane can be used for foundry instruction. Special equipment such as small motors, transformers, wiring, other electrical equipment, and instruments can be used in foundry control and research laboratories. Small parts, tubing and fittings, fasteners and other miscellaneous items are a welcome addition to any foundry or laboratory where construction of apparatus, research and testing are carried on.

Chapter Educational Committees wishing to aid nearby schools should have the educational institutions write to the attention of Mr. Heddleston, War Assets Corp., Aircraft Div., Educational Section, 425 Second St. N.W., Washington 25, D. C., requesting information on the educational disposal of aircraft equipment.

SAND CONTROL IN A BRONZE FOUNDRY

Clinton J. Converse
Crane Ltd.
Montreal, Quebec
Canada

To DISCUSS SAND CONTROL in the bronze foundry, it is only proper to refer to the first man in the Bronze Age, who discovered that metal could be cast more advantageously in molds made with sand than those hewn in stone. No doubt he soon discovered that the quality of his castings depended upon the quality of his sand. Sand that was too wet left him with castings full of holes and hollows and sand that was too dry created imperfect and dirty castings.

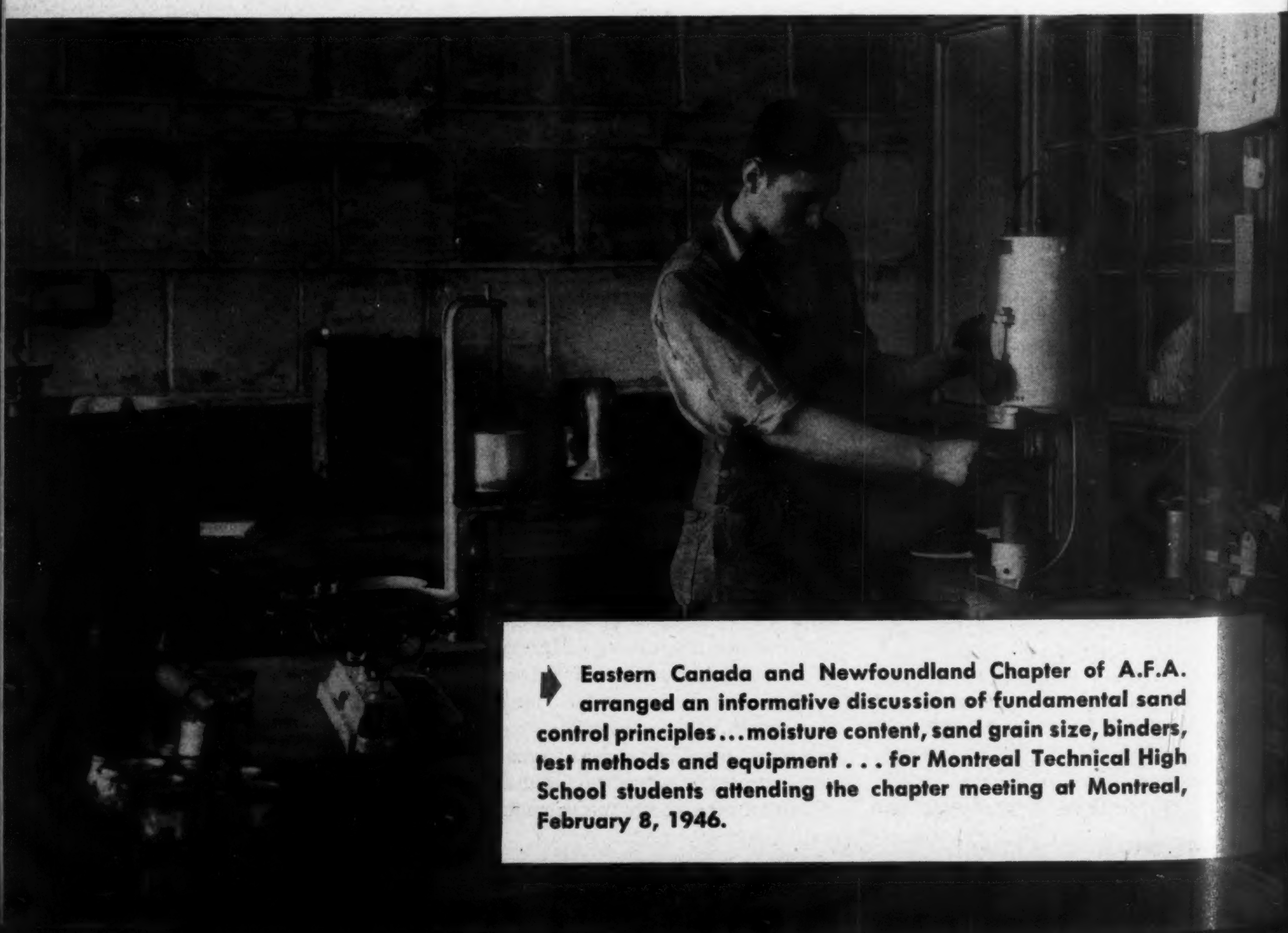
Prudence dictated that to avoid these difficulties he should feel the sand and determine its condition before chancing his labors with the possibility of such unfavorable results. Thus the first *squeeze and feel method* of sand determination was discovered. Later he found that this method indicated to him the surface finish to expect, hence he learned that sand grain size affected the quality of his work.

You may remember when you first went to a beach as a boy and learned to make castles in the sand. When you advanced your foot, buried it with a neat and well patted heap of sand, then withdrew it and stood back to admire your handiwork? That was your first mold.

Then the next time you went to the beach you discovered something else. This time when you withdrew your foot, the castle fell into a shapeless mass. The sand was too dry, so you moved closer to the water. This time the castle kept its form momentarily and then sagged and finally collapsed because the sand was too wet. You were determined not to be fooled again, so you felt the sand the next time before starting the castle. You had discovered the squeeze and feel method yourself. You knew even then that the sand had to be in a certain condition to make a good mold.

A good mold has to have additional characteristics. It has to withstand the sudden shock of molten metal which changes the moisture in the mold to steam and increases its volume about 1,600 times. The hot molten metal creates gases by burning out the organic matter in the sand as well as gases of its own in solidifying. The sand has to be permeable to allow these gases to escape. The hot molten metal also tends to fuse the sand grains together, particularly the small ones. All these factors tend to destroy the bond that provides good molding qualities of the sand.

Scrap castings may result from conditions due to the metal, the



Eastern Canada and Newfoundland Chapter of A.F.A. arranged an informative discussion of fundamental sand control principles ... moisture content, sand grain size, binders, test methods and equipment . . . for Montreal Technical High School students attending the chapter meeting at Montreal, February 8, 1946.

equipment, and the sand. Defects due to the metal are misruns, coldshuts, slag, burning in, pinholes, shrinkage, and leakage. Defects due to equipment are crush, runouts, drops, strain, and shift. Defects due to sand are blow, scab, coldshut, crush, strain, drops, slag, runouts, wash, rough surface, leakage and casting cracks.

Sand accounts for as much scrap as the metal and equipment combined due to sand being too wet, too dry, too strong, too weak, too fine, or too coarse.

Serious study of sands did not begin until the early 1900's. At that time the old squeeze and feel method of sand "testing" was still in vogue and was judged mainly by the foundry foreman. This "test," while giving results that were considered good at that time, left much unexplained. It was known that moisture alone did not impart bond but that moisture was, however, one of the important scrap factors.

Moisture—Early Test

It was natural then that moisture content would be one of the earlier tests evolved. This test consisted of taking a given amount of sand in a container to the core room to be dried out and weighed before and after drying. The results were slow but it did give the foreman a little better knowledge of his sand.

Strength of the sand had become a factor also. It was determined by moving a square stick of molded sand over a plate until its own weight caused the sand to break. This test gave comparative results. Later, due to the interest in finished surfaces the screen test was developed to determine grain fineness. Mold hardness was tested by pressing the finger into the mold.

Perhaps the most interesting and informational test that was developed during this period was that known as the *vibrating test*. This method made use of an 8-oz. straight-sided bottle into which was placed a given amount of heap, facing, or new sand with enough water to nearly fill the bottle. The bottle was then shaken thoroughly and placed on a vibrating plate and held long enough to allow the grains to stratify.

Larger grains settled rapidly to the bottom, followed by the smaller sizes. The final result showed a distinct dividing line between the sand and the clay which settled last. The fines formed their own layer in the bottle between the clay and the coarser grains. This stratification showed the amount of so-called bond, fines, and the amount of heavier grains in the sand. Grain size, amount of fines, and bond were all indicated by this test.

Casting Defects Remedied

After correlating percentage of scrap castings with sand conditions, optimum sand conditions could be maintained to minimize rejects. If you refer to the Dietert Casting Defect Chart you will note that remedies for any particular defect shown, other than that due to moisture, suggest themselves in the bottle test.

Let us consider the defect—*blow*. The chart states in the column under Permeability, "Reduce fines or increase grain size." The bottle test indicates an overabundance of fines when testing sand causing blows. Under Green Strength the remedy is "Reduce clay." Too much clay also will be evident in the bottle test. For *drop*, under Green Strength, the chart reads "Increase clay or mixing." The bottle test indicates too little bond. For *scab* under Permeability, the chart indicates a reduction of fines or an increase of grain size. This is also indicated by the bottle test as is the decrease in clay under Green Strength.

The slowness of the test, which required 12 hr., was the main objection to it although very favorable results were had. Interest in the study of sand continued to grow and marked strides have been made in the past two decades since organized investigations began.

Grain Size

Today, with the modern mechanized foundry, we are interested primarily in grain size of sands, because it determines the surface finish and soundness of castings. This is very important in castings that are pressure tested or plated.

Grain size also determines the permeability of the mold. The screen test is a necessity for best results in these types of castings. Next, comes clay content, for there must be enough binder to hold these grains together. When too little clay is used wash becomes a vital factor in addition to the usual troubles from weak sand. One little sand hole, which may mean nothing in some castings, will scrap one that is to be plated. When too much clay is used defects from strong sand develop. Core sands should also be comparable in grain size to the molding sand, so they will not change the system sand's characteristics.

Moisture, which controls the temper of the sand, must be watched carefully. In addition to a source of blows the metal will not rest quietly on wet sand and by loosening, the grains will cause slag to form within the mold and sandholes from wash.

Moisture Controlled

Sand, clay, and moisture are controlled in the mechanized system by mixing in a batch mixer which takes a weighed amount of system sand from hoppers, mixes it with a measured amount of water and mulls it for a definite length of time to blend the mix thoroughly, assuring the proper distribution of clay to coat the sand grains. New sand is also added at this point. The sand is later revivified to create a fluffiness that aids better molding. While a natural sand is used, enough bentonite is added to take care of the core sand build up. With this sand, which tests about 140 grain fineness, 5 per cent-6 per cent moisture, green strength of 10 and permeability of 18 to 20, the author casts red brass, yellow brass, manganese bronze, copper, and aluminum without facing sands.

In the very near future, the "sandoligist" is going to play an ever more important part in the production of sound castings. He will be as important as the metallurgist.

The end of research in sands is not in sight. Better sand control is going to provide better castings. Better castings are going to provide better business for the foundryman.

New Reference Publication

Scientific Development Corp., 614 W. 49th St., New York, will start in May a weekly publication entitled *"Public Domain."* A 250-page reference book containing over 1000 patents which are due to expire, the publication will include a drawing of each patent together with a digest of typical claims and salient features.

YOU MUST HAVE THE 4th "E" in FOUNDRY SAFETY

James A. Downey, Jr.
Director of Personnel & Safety
Sloss-Sheffield Steel & Iron Co.
Birmingham, Ala.

THE WRITER SPENT some time recently reading various trade publications, especially Safety articles, and in an old safety publication there appeared an article headed by the following in bold type:

"Engineering, Education and Enforcement—NUTS!"

The author of that article made the comment that he was sick of hearing the alliteration "Engineering, Education and Enforcement" as the wrapped-up-package answer to all safety problems. "In the first place," he said, "engineering doesn't sum up the technical aspects of the safety man's job. It ignores entirely the fact that the most competent technical man who ever lived will never get his ideas beyond the drawing board unless he's a diplomat, a salesman and a fighter as well.

"Education implies a classes-and-lessons sort of thing, a self-conscious instruction in safety, a 'mustn't touch' juvenility. On the contrary, the best safety teaching leaves the learner more or less unaware that he has been learning safety at all. He's just learning his job. Safety isn't a door prize or the second item at a one cent sale.

"Of the three words, 'enforcement' causes us the worst neuralgia. In industry, enforcement shows up a bill of goods not sold. In traffic it's only a second best way of making the best of our unfinished business. Any way you look at it, 'enforcement,' although one of our current facts of life, merely takes up the slack caused by our failure to do our stuff so that people believe in it—and in us.

"Friends," he concluded, "let's agree that 'engineering, education and enforcement' are three nice words, they all begin with the same letter, and they all have limited use in safety—*but never as a substitute for original ideas.*"

Fourth "E" Is Enthusiasm

The writer agrees with these statements. However, there is also a fourth "E" that is vital to the success of any safety program . . . *Enthusiasm.* You must have the Fourth "E," Enthusiasm, in foundry safety.

Safety Enthusiasm and the Boss

Safety work in a foundry must begin at the top. The boss must be enthusiastic about safety, since every job that men do involves some degree of hazard and each produces its share of injuries. By proper attention to safety, almost all injuries can be prevented in any kind of work, in any occupation. Since all authority, executive direction and determination of policies must come from management, so must enthusiasm for safety emanate from the top.

Management must *want* to eliminate injuries and lost-time accidents badly enough to make prevention a vital part of all activities. Prevention must receive continuous attention, along with such matters as cost, quality and production.

A foundry where the "Boss" has "Enthusiasm for Safety" is usually a foundry that has a good safety record and, along with this, good housekeeping and good production. It is only natural for one to follow the others. Don't get the idea that it is a one-man job, but with Safety Enthusiasm the entire personnel will become trained, educated and stimulated to follow safe methods of work. They will take a sincere interest in the safety of themselves and their fellow workers.

If management has proper Enthusiasm for Safety, there will be a fixed plan to combat accidents, and this calls for an accurate record of all accidents, and a study made of causes. Plants are required by law, or by company or insurance regulations to prepare certain reports giving pertinent facts when an accident occurs. The clerical work involved is voluminous, hence, the *best accident report is one having NO accidents to report.*

While on the subject of reports, after a worker is injured someone has to do his work, which means hiring a man. Have you ever stopped to think how many forms have to be filled in to put a new employee to work? Here again the clerical work involved is heavy.

With the Boss enthusiastic for safety, it is a simple matter to induce

This discussion on Safety in the Foundry was presented at the 14th Annual Foundry Practice Conference of the Birmingham District Chapter of A.F.A., February 15, 1946, at the Tutwiler Hotel, Birmingham, Ala. The Fourth "E" in Foundry Safety is Enthusiasm. Enthusiasm for safety must be demonstrated by management and supervision before the lower bracket can get enthusiastic about safety. The other three E's are Engineering, Education, and Enforcement.

the Employment Office and Timekeeping Department to become enthusiastic for safety, since their clerical load can be greatly reduced by reducing accidents to the minimum. Just a few words to the new employee, from the first person he meets, about his personal safety and the plant's safety record, will make a lasting impression. If a man has to take a physical examination, the enthusiasm of the doctor can help. While checking the employee's physical condition, a few side remarks about the Safety Program will help.

The most important job of all falls on the foreman. Enthusiasm must be sincere. The foreman must set an example and must maintain safety-minded supervision for the management, because management alone can do but half a job. In too many cases we expect the workers to make the safety program without the enthusiasm of management. Some plants seem to feel that if they belong to the National Safety Council and put up a few posters and signs about the property, management's share of safety work is done; from then on it is up to the workers.

Safety Inventory Needed

Most foundries take an annual stock inventory, simply as a business requirement. However, a safety inventory is also a business requirement in order for a plant to know its accident frequency and severity rate during the previous year? How do these figures compare with the rates of others engaged in the same kind of work?

If these figures are not known, the plant should take stock, check the accident records and investigations, compile statistical information and compare the data gained with those of competitors. Safety promotion is peculiar in that it is the one phase of a competitor's business on which he is willing to give figures. The cost accountants lock up their cost and production figures in the safe every night and work behind closed doors, but safety figures are posted on the bulletin boards and even in the newspapers, radio, etc.

After the foundry has taken safety "stock" and knows where its accidents occurred, which foremen had the most accidents, which department had the best record, which men are accident prone, accidents should then be classified as to cause, part of body injured, time of day; by race, age, length of service of employee, and how the accident experience compared with other foundries. When this information is placed in the hands of the foremen, their Enthusiasm for Safety will increase materially.

Make Safety a Game

Americans love sports. They love competition and they like to read the baseball scores, football standings and track records. They'll be interested in the competitive phases of safety if given an opportunity.

Years ago in one of the writer's plants, a certain foreman could not be interested in safety work. He believed that safety work was merely a lot of "school-boy stuff." He became interested, however, when the plant organized a safety contest, with results reported on a miniature Indianapolis Speedway built with 365 divisions (one for each day) marked off around the track. Each department was represented by a racing car which was advanced each day the department worked safely; but when an accident occurred the car stopped and did not move until the injured employee returned to work.

An accident occurred in the mechanical gang and this foreman's car was stopped, while the other cars moved on day by day. Daily as he passed the track, the foreman saw his car standing there. One day he turned up with a long-spouted oil can and poured oil all over the car. When questioned, he replied that he had grown tired of seeing the car standing there so went out to see the injured worker and, when he found that the man was coming back to work in a few days, the foreman decided he would see that his car did not stop again all year. Incidentally, that was the first time he had ever visited one of his injured men while disabled.

Workers' Interest Pays Dividends

There are many ways to kindle the enthusiasm of workers. It has been the writer's experience that where enthusiasm by management has been manifested, many workers also become enthusiastic. Some even become over-enthusiastic and then enthusiasm becomes, as Wilton says, "a religious fanaticism." Even this sort of enthusiasm can be curbed and turned to good advantage. The writer has yet to see a foundry that does not have a "preacher" working on the floor, and if he must preach, let him preach Safety.

Every employee must do his part to avoid being injured, but the safety program must be carried to him so that he can become a part of it. Safety committees cannot be a substitute for management's interest, but they can be a channel to obtain the interest of employees. Safety is a tool of management that will be effective in proportion to the way it is fashioned and directed.

Your Safety Committee must be so constituted and conducted as to merit the support and confidence of the employees. Their recommendations must be taken seriously and complied with or proved impractical.

How to Get Cooperation

With the proper amount of sincere Enthusiasm for Safety shown by management the cooperation of the worker can be easily obtained. Some ways in which a worker can cooperate are listed below:

(1) Working earnestly on Safety Committees or other safety activities to which he may be assigned.

(2) Understanding and carefully following safety rules and instructions.

(3) Reporting all hazardous conditions.

(4) Being as enthusiastic about the safety of his fellow worker as he is about his own.

(5) Faithfully using all safeguards as provided, and always seeking the safe way for doing each job.

We know that by preventing accidents we are preventing human suffering, misery and deprivation. This is a heart-warming thing; but it is a cold fact that accident costs are wholly waste. It is a still colder fact that the indirect cost is four times greater than the direct cost.

Locally and nationally, foundries large and small have proved, by the use of the Fourth "E" in Foundry Safety—Enthusiasm for Safety—and by proper planning, that at least 9 out of every 10 injuries can be prevented by means available to every employer and his employees.

A good safety motto to follow is this: *It CAN be done—Safety Enthusiasm pays dividends.*

An Open Letter to a Foundry Executive

It takes more than one man to operate a modern foundry.

The day of the "one-man plant" in the foundry field is over, for certainly no one man today can keep up with the tide of current business affairs and still get out production under today's terrific demand. So much new information on castings production is coming to light constantly that even the most outstanding metallurgists and operating men find it difficult to keep up with scientific and engineering advancements in the foundry field. It is only through the combined information of many that the modern castings producer can meet the challenge of competitive processes and products.

The American Foundrymen's Association therefore invites you, Mr. Foundry Executive, to see that your key men hold membership in A.F.A., the technical society serving all branches of the castings industry.

Today the activities of a plant, large or small, can be carried on adequately only if the supervisors keep abreast of developments in sand, molding, melting, cleaning and foundry control. In any plant, too, there are younger men who have come into the industry in recent years upon whose knowledge and experience will depend the progress of individual plants. To enable these men to broaden their information and usefulness is simply good business.

It has been said, and wisely, that "the best form of training is the personal exchange of information from man to man." Membership in American Foundrymen's Association provides such an exchange between the men in the industry.

For this reason, Mr. Foundry Executive, we suggest that you check the memberships held by your key men in the A.F.A. to the end that no man upon whom you depend for castings production is without a constant year 'round source of information vital to his work . . . and to your company's progress.

AMERICAN FOUNDRYMEN'S ASSOCIATION

The Annual Foundry Congress

The one event the entire industry normally looks forward to every year, sponsored by A.F.A. and long recognized as perhaps the most important gathering of foundrymen in the world. Here the latest developments in castings production and research are openly discussed.

A glance at the 50th Anniversary Convention Program elsewhere in this issue should convince you that this is a "must" for your key men.

The Foundry Show

At the Foundry Show you will see all types of equipment and supplies for producing more castings and better castings, at less cost. You can inspect materials, methods and processes useful to your work. You may discuss with representatives of exhibiting firms your special production and maintenance problems. And you may inspect the actual application of many products on Plant Visitation tours.

The 1946 Foundry Show May 6-10 will be the largest and most important ever staged by A.F.A. "Know by seeing" what is available for foundry production today.

Chapter Meetings

As a member of A.F.A. you may, without paying any extra dues, take an active part in one of the 33 A.F.A. Chapters throughout the country . . . attend all meetings, serve on committees, perhaps be elected a Chapter officer or director. Each Chapter holds at least eight meetings a year, with well-founded programs.

There may be a Chapter in your territory . ... if there is, see that your supervisors attend regularly.

Educational Courses

There is value in A.F.A. activities for *every* member of the Foundry Industry, from apprentice to president. Convention shop courses, national apprentice contests, Chapter round table groups, and Regional meetings all appeal primarily to shop men, apprentices and students. A.F.A. also cooperates with Chapters in sponsoring Edu-

cational Courses in addition to regular Chapter meetings. Fundamental in nature, the courses present a clear, concise outline of basic foundry practice, broaden a man's outlook, and increase his ability to get ahead. Would they help *your plant* and *your shop men?*

Committee Activities

If you could lay your shop problems before 400 practical, able men of the industry, would you stand a good chance of solving them? Well, over 400 men of skill and experience give valuable time and knowledge, gratis, in A.F.A. Committee work to improve the quality of cast products—*your products.*

A.F.A. welcomes members to Committee Service, the backbone of the Association. It gives a man splendid opportunities to meet foundry leaders, prove his own ability, gain more intimate knowledge of specific subjects, and *actively* advance his firm's interests. How many of your supervisors, Mr. Foundry Executive, have ever served on technical committees of A.F.A.?

The Foundry Practice Library

Accurate information on practically every major advancement in foundry practice over the past 50 years can be found in the A.F.A. Foundry Practice Library . . . a cast metals library second to none. Hundreds of men throughout the industry constantly add new research data, new shop information and experience to keep it up to date and of utmost practical worth. The actual dollars-and-cents value of this material to your work far exceeds the cost of membership.

How much of the A.F.A. published material, Mr. Executive, is in the hands of the men upon whom your company depends for quality production?

No man, no business, no industry stands still. They either go backward—or forward. The men who play an active part in A.F.A. affairs are doing their part to keep the foundry industry going forward. Getting down to cases, Mr. Foundry Executive, isn't this good reason why it is to your interest that your key men hold membership in A.F.A.?

MEMBERSHIP CLASSES AND ANNUAL DUES

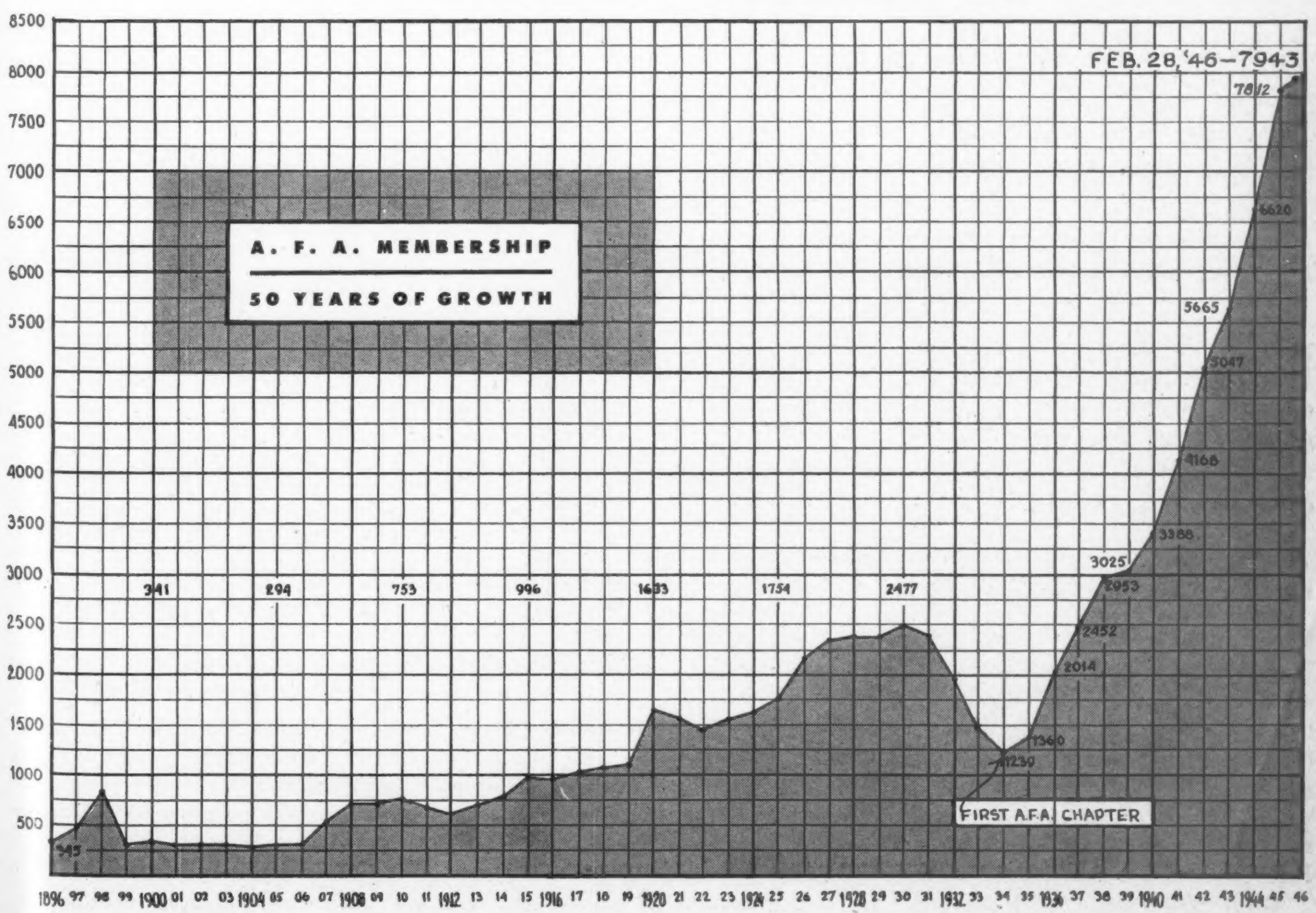
(Effective July 1, 1945)

	Annual Dues
SUSTAINING Membership	**Minimum $100.00**
Firms electing Sustaining Membership are requested to state such annual amount as best expresses their desire to support the Association's aims and purposes.	
COMPANY Membership	**$50.00**
PERSONAL Membership	**$15.00**
PERSONAL (Affiliate) Membership	**$8.00**
(NOTE: Sustaining and Company membership privileges apply ONLY to the plant or general office of an organization having such membership. Any individual affiliated with a plant holding a Sustaining or Company membership may become a Personal member at $8.00.)	
PERSONAL (Associate) Membership	**$8.00**
Individuals may become PERSONAL (Associate) members at only $8.00 per year, if engaged solely in Educational, Government or Military work.	
STUDENT or APPRENTICE Membership	**$4.00**

For additional information, write

AMERICAN FOUNDRYMEN'S ASSOCIATION

222 West Adams St., Chicago 6, Ill.



★ NEW A. F. A. MEMBERS ★

(Covering the period from February 15 to March 15)

• This list of 142 new Association Members is ample evidence that the Membership Committees have kept up their vigilance during these busy times. Last year, over the same period of time, 20 chapters reported an increase of 132 members, while this year 27 chapters brought in 123 new applications. Chicago chapter, for the third straight month, heads the list with 11 members, including one new company membership. Metropolitan with 10 and Southern California with 9, including a company member, ranked second and third, respectively. A number of chapters turned in 8 new members. It is interesting to note the number of countries represented in the "outside of chapter" group.

BIRMINGHAM DISTRICT CHAPTER

J. L. Builder, Sls., Republic Steel Co., Birmingham, Ala.
***The Wheland Co., Chattanooga, Tenn. (Charles S. Chisolm, Met.).**

CANTON DISTRICT CHAPTER

***The Bonnot Co., Canton, Ohio. (B. T. Bonnot, President).**
Robert J. Buckley, Supt., Rybolt Heater Co., Ashland, Ohio.
J. Carl Hall, Gen. Mgr., American Cast Products, Inc., Orrville, Ohio.
Ralph E. Kenmuir, Asst. Gen. Fore., American Steel Foundries, Alliance, Ohio.
Theodore W. Lieber, Molder, The Lectromelt Castings Co., Barberton, Ohio.
Fred S. Price, Mgr., Union Spring & Mfg. Co., New Kensington, Pa.

CENTRAL ILLINOIS CHAPTER

Jay Draper, Foreman, Caterpillar Tractor Co., Peoria, Ill.
George H. Greene, Foreman, Caterpillar Tractor Co., Peoria, Ill.
Leo A. Miller, Caterpillar Tractor Co., Peoria, Ill.
Joseph L. Oberle, Caterpillar Tractor Co., Peoria, Ill.
Edward J. Rice, Foreman, Caterpillar Tractor Co., Peoria, Ill.
C. W. Russell, Purch. Dept., Caterpillar Tractor Co., Peoria, Ill.
George L. Schenck, Owner, Geo. L. Schenck & Sons Pattern Shop, Peoria, Ill.
Donald A. Wise, Foreman, Caterpillar Tractor Co., Peoria, Ill.

CENTRAL INDIANA CHAPTER

***Indianapolis Naval Ordnance Plant, Indianapolis. (John E. Mitchell, Mat. Engr.).**
Wilbur L. Wolfe, National Malleable & Steel Castings Co., Indianapolis.

CENTRAL NEW YORK CHAPTER

B. Benassi, Supv., Goulds Pumps Inc., Seneca Falls, N. Y.
Lewis E. Irish, Pattern Shop Supt., Goulds Pumps Inc., Seneca Falls, N. Y.
Lewis E. Jarvis, Supt., Goulds Pumps Inc., Seneca Falls, N. Y.

CENTRAL OHIO CHAPTER

Carl Ultes, Jr., Prod. Mgr., O. S. Kelly Co., Springfield, Ohio.

CHESAPEAKE CHAPTER

R. E. Martin, Foreman, Pangborn Corp., Hagerstown, Md.

CHICAGO CHAPTER

M. F. Becker, M. F. Becker & Associates, Chicago.
Anthony Carmoli, Asst. Gen. Fore., American Steel Foundries, East Chicago, Ind.
***Certified Core Oil Div., Socony-Vacuum Oil Co., Inc., (Alanson J. Donald) Cicero, Ill.**
T. A. Cizma, Asst. Foundry Supt., National Malleable & Steel Castings Co., Cicero, Ill.
C. Geo. Hillyer, Lester B. Knight & Associates, Inc., Chicago.
W. E. Mahin, Chairman, Metals & Min. Div., Armour Research Foundation, Chicago.
George A. Murphy, Sales, Edw. F. Christensen Co., Chicago.
J. G. Poleck, Engr., Lester B. Knight & Associates, Chicago.
John F. Richardson, Salesman, Smith & Richardson Mfg. Co., Geneva, Ill.
Harold L. Smith, Engr., Smith & Richardson Mfg. Co., Geneva, Ill.
Ernest A. Urbrock, Industrial Pattern Works, Chicago.

CINCINNATI DISTRICT CHAPTER

W. J. Prestel, Vice-Pres., Ohio Precision Castings, Inc., Dayton, Ohio.

*Company Members.

DETROIT CHAPTER

Roger W. Braden, General Refractories Co., Detroit.
Robert E. Cleland, Salesman, Eastern Clay Products Inc., Detroit.
Eugene J. Passman, Met., Frederic B. Stevens, Inc., Detroit.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Graham W. Paterson, Dist. Mgr., Refractories Eng. & Supplies, Ltd., Montreal, Que.
Jean Luc Trottier, Molder, La Fonderie Inc., Portneuf, Que.
William Wright, Dominion Engineering Works, Lachine, Que.

METROPOLITAN CHAPTER

M. A. Ajzenberg, M. E., Whiting Corp., New York.
John J. Fitzgibbon, Fdry. Engr., Whitehead Metal Products Co., Inc., New York.
Morris Gittleman, Engineering Aid Met., New York Naval Shipyard, New York.
Daniel J. Jones, Salesman, New Jersey Silica Sand Co., Millville, N. J.
Gordon I. Lindsay, Jr., Robeson Process Co., New York.
James P. McLaughlin, Sterling Wheelbarrow Co., New York.
Cornelius C. Olifiers, President, Boan Pattern Co., Inc., New York.
Charles Schwalje, Fdry. Engr., Worthington Pump & Machinery Corp., Harrison, N. J.
Frank A. Streiff, Jr., Sales Appr., American Brake Shoe Co., Mahwah, N. J.
Robert R. Waltien, Met., New York Naval Shipyard, Brooklyn, N. Y.

MICHIANA CHAPTER

C. D. Merrill, Vice-Pres., M. B. Skinner, South Bend, Ind.
A. J. Rumely, Jr., Sec., La Porte Foundry Co., La Porte, Ind.
Jack F. Secor, Sand Tester, Clark Equipment Co., Buchanan, Mich.

NORTHEASTERN OHIO CHAPTER

H. M. Chatfield, Ref. Engr., American Crucible Co., Shelton, Conn.
John Davenport, Fulton Foundry & Machine Co., Inc., Cleveland.
William C. George, Engr., Electro. Alloys Div., American Brake Shoe Co., Elyria, Ohio.
Eugene Kment, Met., Aluminum Co. of America, Cleveland.
Archie Stevenson, Foreman, Fulton Foundry & Machine Co., Inc., Cleveland.

NORTHERN CALIFORNIA CHAPTER

Floyd J. Biava, Navy Shipyard, Mare Island, Calif.
Ellis Strief, Leadingman, Patternmaker, Mare Island Ship Yard, Mare Island, Calif.
William J. Weber, SP Leadingman, Mare Island Ship Yard, Mare Island, Calif.

NORTHWESTERN PENNSYLVANIA CHAPTER

Arthur Nieman, Federated Metals Div., Cleveland.

ONTARIO CHAPTER

Norman L. Bennett, Met., Massey-Harris Co., Ltd., Brantford, Ont.
R. E. Bisset, Foster Wheeler, Ltd., St. Catharines, Ont.
Thomas Boaz, Salesman, Frederic B. Stevens of Canada, Ltd., Toronto, Ont.
George E. Driscoll, Instructor, International Harvester Co., Hamilton, Ont.
***Foster Wheeler, Ltd., St. Catharines, Ont. (George Macnoe, Pres.).**
D. J. Laraman, Foster Wheeler Ltd., St. Catharines, Ont.
Courtney Mason, Foster Wheeler Ltd., St. Catharines, Ont.
***The Northern Engineering & Supply Co., Fort William, Ont. (J. M. Paton, G. M.).**

OREGON CHAPTER

C. M. Holmes, Sand Tech., Crawford & Doherty Foundry Co., Portland Ore.
Carrol G. Stirnwais, Chem., Crawford & Doherty Foundry Co., Portland, Ore.

PHILADELPHIA CHAPTER

John P. Brull, Chief Chemist, North American Smelting Co., Philadelphia.
Theodore O. Bjonson, Repr., American Crucible Co., Shelton, Conn.
Fernand A. Flory, Met., Dodge Steel Co., Philadelphia.
Martin P. Gray, Met., Empire Steel Castings Inc., Reading, Pa.
Alfred Holroyd, Asst. Fore., Crucible Steel Casting Co., Lansdowne, Pa.
V. G. Miskjian, Designer, Baldwin Locomotive Works, Eddystone, Pa.

QUAD CITY CHAPTER

Frank Eastman, Mgr., Viking Pump Co., Iron Foundry Div., Cedar Falls, Iowa.
William J. Wilson, Mgr., Viking Pump Co., Brass Foundry Div., Cedar Falls, Iowa.

SAGINAW VALLEY CHAPTER

Howard R. Johnson, Plant Engr., Eaton Mfg. Co., Foundry Div., Vassar, Mich.
D. F. Murphy, Met., Engr., Besser Mfg. Co., Alpena, Mich.
Frank C. Pakulski, Chevrolet Gray Iron Foundry, Saginaw, Mich.
Charles Reynolds, Fdry. Supt., Besser Mfg. Co., Alpena, Mich.
Carl F. Wood, Jr., Mech. Engr., Chevrolet Gray Iron Foundry, Saginaw, Mich.

ST. LOUIS DISTRICT CHAPTER

J. R. Anderson, Midwest Foundry, Inc., Wichita, Kansas.
Russell E. Hard, Salesman, M. W. Warren Coke Co., St. Louis.
Harry E. Harder, Supt., City Plating & Mfg. Co., St. Louis.
Wayne B. Lake, Sales Repr., Permanente Products Co., Akron, Ohio.
***Midwest Foundry Inc., Wichita, Kansas. (A. R. Frenette, Pres.).**
L. C. Parrish, Midwest Foundry Inc., Wichita, Kansas.
George J. Rundbald, Salesman, Pickands Mather & Co., St. Louis.
R. G. Thompson, Laclede Christy Clay Products Co., St. Louis.

SOUTHERN CALIFORNIA CHAPTER

J. F. Addington, Ingersoll-Rand Co., Los Angeles.
Henry T. Flores, Maritime Brass & Bronze Works, Haber City, Calif.
Ray Hopping, Partner, Hoppings Foundry, Pasadena, Calif.
***Howell Foundry Co., Inc., Los Nietos, Calif. (Henry W. Howell, Pres.).**
Dean Howell, Howell Foundry Co. Inc., Los Nietos, Calif.
F. H. Krauss, Partner, K & L Pattern & Mfg. Co., Lynwood, Calif.
D. J. Lancaster, Partner, K & L Pattern & Mfg. Co., Lynwood, Calif.
J. Robert Langston, Howell Foundry Co. Inc., Los Nietos, Calif.
C. M. Serfling, F. E. Schundler & Co., Inc., Los Angeles.

TEXAS CHAPTER

J. Elbert Johnson, Sales Repr., A B C Coal & Coke Co., Birmingham, Ala.

TOLEDO CHAPTER

Edgar C. Smith, Supt. of Foundries, Lima Locomotive Works, Inc., Lima, Ohio.
Leo J. Suber, Mgr., Deshler Foundry & Machine Works, Deshler, Ohio.

TWIN CITY CHAPTER

Joe Goldberg, President, South Park Foundry & Mfg. Co., S. St. Paul, Minn.
Paschas Goldberg, Sec'y, South Park Foundry & Mfg. Co., S. St. Paul, Minn.
E. G. Gustafson, Salesman, Harris Calorific Sales Co., St. Paul, Minn.
Bert C. Lindgren, Foundry Supt., National Iron Co., Duluth, Minn.
Vernon Northway, Salesman, E. R. Frost Co., Minneapolis.
Earl D. Pittman, Core Foreman, Prospect Foundry, Minneapolis.
J. H. Richards, Salesman, E. F. Houghton Co., St. Paul, Minn.
Edward Sitarz, Partner, Prospect Foundry, Minneapolis.

WISCONSIN CHAPTER

***International Harvester Co., Waukesha Works, Waukesha, Wis.**
Frank McLean Jacobs, Standard Brass Works, Milwaukee.
John L. Kammermeyer, Dist. Repr., Federated Metals Div., American Smelting & Refining Co., Milwaukee.
Oscar H. Kraft, Asst. Fdry. Supt., Bucyrus Erie Co., S. Milwaukee.
Robert K. Langdon, Walter Gerlinger Inc., Milwaukee.
George Marshall, Allis-Chalmers Mfg. Co., Milwaukee.
Edward C. Young, The Hill & Griffith Co., Chicago.

OUTSIDE OF CHAPTER

Pei-Yen Chao, The Standard Stoker Co. Inc. Observer, Erie, Pa.
Four Continent Book Corporation, New York.
T. R. Heyward, Jr., Pres., Duraloy Co., Scottdale, Pa.

Australia

F. V. Tait, Gatie Castings Pty. Ltd., Brunswick, Australia.

Brazil

Arsenal da Marinha da Ilha das Cobras, Rio de Janeiro, Brazil, S.A.
Felipe Nery Costa Pereira, Engr., Cia Metalurgica Barbara, Brazil, S.A.
Marcio Ribeiro Rocha, Sao Paulo, Brazil, S.A.
Edwardo Garcia Rossi, Fabrica de Ferragens Lyrio Ltd., Sao Paulo, Brazil.

China

C. Y. Pei, N.C.R. Shanghai Machine Works, Kiukiang Rd., Shanghai, China.

England

S. T. Jazwinski, Letchworth, Herts., England.
J. T. Robinson, Lab. Contr., High Duty Alloys Ltd., Slouth, Bucks, England.

France

Jacques Bardou, President, S. A. M. P. A., Seine, France.
Hubert M. Cromback, President, De La Societe Anonyme Des Fonderies Cromback, Seine, France.
Delachaux Philippe, Pres., Acieries De Gennevilliers, Seine, France.

Scotland

David Henry Young, Asst. Mgr., Harland & Wolff Ld. Clyde Foundry, Glasgow, Scotland.

South Africa

Charles Olivier Boyd, Met., Asst., Union Steel Corp. of S.A. Ltd. Vereeniging, South Africa.

Sweden

S. Alexanderson, Chief Engr., Wedaverken, Sodertalje, Sweden.
I. Forslund, Met. Engr., A. B. Svenska Kullagerfabriken, Katrineholm, Sweden.
Stig Hj:son Ljunggren, Foundry Mgr., Kohlswa Jernverks A.B., Kolsva, Sweden.
Hilding Nuth, Volvo A/B Goteborg, Sweden.
Hans Rudberg, Civilingenior, Aktiebolaget Farnforadling, Halleforsnas, Sweden.

*Company Members.

Past National Director Thomas Kaveny Dies

THOMAS KAVENY, 67, president of Herman Pneumatic Machine Co., Pittsburgh, Pa., for over 30 years, died March 29 at his home in Canandaigua, N. Y., where he had been confined due to illness for some time past. A National Director of A.F.A. during 1938-1940, Mr. Kaveny was an active member of the Association for more than 30 years and was long active in the Foundry Equipment Manufacturers' Association as well.

Thomas Kaveny

Born in Canandaigua, N. Y., in 1869, he received his early schooling there and, after attending Canandaigua Academy, graduated from Cornell University, Ithaca, N. Y., in engineering. In 1897 he took a position in Chicago as sales manager with the N. K. Fairbanks Co., where he remained for 17 years. He resigned in 1914 to become president of the Herman company, a position he held until his retirement recently.

Under Mr. Kaveny's leadership the Herman company has long played an important role in mechanizing foundry molding operations through the manufacture and development of molding machines originally conceived by Charles Herman, one of the pioneers in the field. Upon his retirement, the presidency of the company was taken over by Mr. Kaveny's son, Thomas Kaveny Jr., present president of the Foundry Equipment Manufacturer's Association.

The loss of Mr. Kaveny to the foundry industry will be felt keenly, especially among the many friends with whom he had been associated in a business capacity, and in the American Foundrymen's Association and the FEMA.

FOUNDRY PERSONALITIES

Roger W. Griswold, Jr., Griswold Mfg. Co., Erie, Pa., has been elected vice-president of the company; **Frank P. Volgstadt** has been appointed general foreman in charge of the foundry; and **Edgar J. Sierk,** formerly with Harrison Radiator Div., General Motors Corp., Lockport, N. Y., has joined the Griswold company as foundry foreman. Mr. Griswold is Chapter Chairman, Northwestern Pennsylvania A.F.A. chapter, of which Mr. Volgstadt is also a member. Mr. Sierk has been an active A.F.A. member in the Western New York chapter.

H. H. Wilder, formerly research metallurgist, Wilson Foundry & Machine Co., Pontiac, Mich., has been appointed chief metallurgist, Foundry Division, Eaton Mfg. Co., Detroit. Mr. Wilder, who is Chairman of the Committee on Chill Tests, A.F.A. Gray Iron Division, and has served as Secretary of the Detroit chapter, was associated with the Gray Iron Foundry Section, W.P.B., Washington, D. C., during the war.

H. H. Wilder E. D. Trout

E. Dale Trout has been named director, technical service department, G-E X-ray Corp., Chicago. He will coordinate all types of technical advisory services.

August T. Luebke, associated with Greenlee Bros. & Co., Rockford, Ill., since 1915, has retired after approximately 59 years service to the foundry industry. Starting his foundry career as hodcarrier with Northwestern Link Belt Co., Milwaukee, in 1887, Mr. Luebke moved to Beloit, Wis., where he was connected

A. T. Luebke

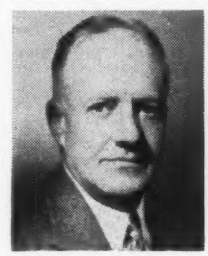
with Beloit Iron Works, Fairbanks-Morse Co. and Beloit Foundry Co. before joining Greenlee Bros. & Co. as superintendent of the core department.

H. S. Washburn, president-treasurer, Foster Machine Co., Westfield, Mass., has been elected chairman of the board. **W. C. Chisholm,** company executive vice-president and treasurer since 1944, has been made president-treasurer, succeeding Mr. Washburn.

Mr. Washburn is a past National President, Vice-President and Director of A.F.A.

H. E. Beane, sales manager, Bristol Co., Waterbury, Conn., announces the appointments of: **G. H. Gaites,** regional sales supervisor of Cleveland and Pittsburgh sales territories, as district manager of the company's New York office, and **H. A. Van Hala,** as district manager of the Cleveland office. Mr. Van Hala has served as district manager of the Birmingham office since 1935. **Charles Webber** has been appointed managing director, Bristol Co. of Canada, Ltd., Toronto, Ont., according to announcement by **H. H. Bristol,** president of the Canadian firm.

Jacques Bardou, president, S.A.M. P. A., Paris, France; **Hubert Cromback,** director general, Acieries Thome Cromback, Paris; and **S. Alexanderson,** chief engineer, Bofors Light Alloy Factory, Wedaverken, Sweden, were recent distinguished visitors to the A.F.A. National Office. Messrs. Bardou and Cromback, both A.F.A. members, are among a party of French industrialists visiting manufacturing centers in this country. Mr. Alexanderson, also an A.F.A. member, is studying magnesium foundry production methods in this country, and expects to remain long enough to participate in the 50th Anniversary Convention in Cleveland, May 6-10.



H. S. Washburn A. B. Root, Jr.

A. B. Root, Jr., A.F.A. Past President, has severed his connection as vice-president, Hunt-Spiller Mfg. Corp., Boston, with which company he had been connected for 32 years, and is now vice-president and general manager, Foster Machine Co., Westfield, Mass.

After serving three years as a director of A.F.A., Mr. Root was elected Vice-President in 1925 and President in 1926. As President he presided at the Second International Foundry Congress, the first to be held in America, staged in Detroit, September, 1926.

C. R. Reeves has been appointed works manager, Kalamazoo Stove & Furnace Co., Kalamazoo, Mich., **A. L. Blakeslee,** company president, has announced. Mr. Reeves joined the firm in 1942 to manage production of parachute flares under government contract. Formerly production engineer with Associated Engineers,

Ft. Wayne, Ind., Mr. Reeves also has been associated with Rayon Machinery Corp., Cleveland, and Link Belt Co., Indianapolis.

M. J. Gross has been named manager of engineering, General Electric X-Ray Corp., Chicago, Ill., **J. H. Glough,** president of the corporation, has announced. Mr. Gross, who returned recently from conducting a technical investigation in Germany on government assignment, served three years as a technical liaison officer with the Army Medical Administration Corp before being released to inactive duty, in July, 1945, to undertake the assignment. He joined General Electric X-Ray in 1931 as head of the Vacuum Tube Department and was appointed engineer assistant to factory manager **F. E. Scheven** in 1937.

M. J. Gross

C. V. Nass

E. J. Seifert has assumed the position of president and treasurer, **C. V. Nass** that of vice-president, and **E. S. Cummings, Jr.,** that of secretary of Beardsley & Piper Co., Chicago, Ill., which has been acquired through cash purchase by Pettibone Mulliken Corp. of the same city and will operate as a wholly-owned subsidiary under the same name. The foregoing officers also will constitute the board of directors. **E. O. Beardsley** and **W. F. Piper** will remain as engineering consultants.

Mr. Nass has been prominent in technical commitees of A.F.A. nonferrous groups and is at present a member of the Subcommittee on Training Graduate Engineers in Industry, A.F.A. Committee on Cooperation with Engineering Schools.

W. A. Blume, president, American Brakeblok Div., American Brake Shoe Co., New York, announces purchase by the firm of 40 acres in Winchester, Va., upon which a new plant will be erected. Construction of the plant will be a part of the firm's expansion program, which includes plans for facilities at Lindsay, Ont., and Mahwah, N. J.

C. H. Anderson, vice-president and general manager, Crown Iron Works Co., Minneapolis, has been elected to the board of directors, Midland National Bank & Trust Co., Minneapolis. Mr. Anderson is a Chapter Director and former Chapter Chairman, A.F.A. Twin City chapter.

Harry Wilson, Jr., has been elected first vice-president, Jessop Steel Co., Washington, Pa., with which firm he has been associated for the past 40 years, as general superintendent, works manager and vice-president in charge of operations.

Woodruff A. Morey, formerly Major, Army Ordnance, has rejoined Mann & Brown, Chicago, with which firm he was associated before entering military service. Speaker at numerous A.F.A. chapter meetings, Mr. Morey is a member of the Recommended Practices on Precision Casting Committee, Brass and Bronze Division, and author of the technical paper, *"Industrial Status of Precision Castings,"* which appeared in AMERICAN FOUNDRYMAN, October, 1945.

C. H. Anderson

James Gerity, Jr., has been elected chairman of the board, and **L. W. Blauman** president of Gerity-Michigan Die Casting Co., a recently announced merger of Michigan Die Casting Co., Detroit, and Gerity-Adrian Mfg. Corp., Adrian, Mich. Other officers are: **E. M. Tallberg, W. N. Schnell,** and **Charles Shanks,** vice-presidents; **J. T. Bolan,** secretary, and **M. K. Layer,** treasurer.

Gehnrich Oven Div., W. S. Rockwell Co., announce their new general headquarters at 200 Eliot St., Fairfield, Conn.

W. A. Morey

W. B. Given, Jr., president, American Brake Shoe Co., New York, has reported to stockholders a twelve and one-half million dollar expansion and improvement program. Five of seven new plants contemplated will be foundries.

Victor L. Persbacker was elected assistant comptroller, American Brake Shoe Co., Canadian Ramapo Iron Works Ltd., and Dominion Brake Shoe Co., Ltd.

Sumner Simpson, president, Raybestos-Manhattan, Inc., has announced assumption by **H. E. Smith,** Manhattan Div., Passaic, N. J., corporation vice-president, of complete charge of rubber product sales and marketing for the firm.

A. P. Miller, Inland Steel Co., East Chicago, Ind., has been elected chairman, National Open Hearth Steel Committee, American Institute of Mining and Metallurgical Engineers, **F. T. Sisco,** secretary, AIME, has announced. **E. L. Ramsey,** Wisconsin Steel Works, South Chicago, Ill., has been elected vice-chairman of the committee, and Mr. Sisco continues as committee secretary. Mr. Miller will preside at the 29th

(Continued on Page 210)

★ CHAPTER ACTIVITIES ★

news

Chesapeake

Lt. J. T. Robertson, USNR
Naval Research Laboratory
Chapter Reporter

VISITING AS GUEST SPEAKER at the February meeting of the Chesapeake chapter, in the Engineers' Club, Baltimore, Md., Central Ohio Chapter Co-Chairman N. J. Dunbeck, Eastern Clay Products Inc., Eifort, Ohio, presented a discussion of "Synthetic Sand."

Mr. Dunbeck, who is active in the A.F.A. Foundry Sand Research Project, considered three aspects of his subject: what type of foundry should use synthetic sand; what type of clay should be used; and, how to make the use of synthetic sand economical.

Following the speaker's remarks, Chapter Vice-Chairman David Tamor, American Chain & Cable Co., York, Pa., presiding, called upon National Director Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va., and Wally Levi, of the same firm, to open the discussion period with comments on their own experiences with synthetic sand. Howard Williams, New Jersey Silica Sand Co., Millville, N. J., and Chapter Director J. W. Mentzer, Taggart & Co., Philadelphia, also contributed to the discussion.

Chicago

E. F. Ross
The Foundry
Chapter Reporter

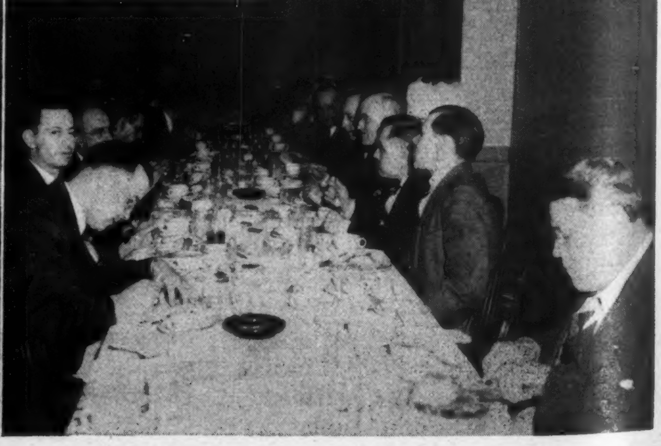
FRENCH FOUNDRYMEN were guests of the Chicago chapter on the occasion of its March meeting, at the Chicago Bar Association, with Chapter Vice-Chairman L. H. Hahn, Sivyer Steel Casting Co., Chicago, presiding, and A. F. Pfeiffer, Allis-Chalmers Mfg. Co., Milwaukee, presenting a discussion of dimensional control of sand castings.

The chapter was host to: Paul de Rosiere, Fonderies de Creil, Paris; Jacques Bardou, S.A.M.P.A., Paris; Hubert Cromback, Acieries Thome Cromback, Paris; Jean Gustin, Ets. Gustin Fils, Deville, Ardennes; Pierre Maillat, Ets. Guiot, Neuilly, Seine; and Jean Martiny, Fonderies Jean Martiny, Mont-Saint-Aignan. All are members of a French group touring industrial centers in this country.

Speaking in behalf of the group, M. De Rosiere expressed appreciation for American hospitality, and explained that the purpose of the mission was to study new American methods and equipment which could be of assistance in rehabilitation of French foundries. He described deterioration and damage in French plants during German occupation, and reported that casting production, although far below prewar

Some views of the February meeting of the Chesapeake chapter, at which N. J. Dunbeck (above right), Eastern Clay Products, Inc., Eifort, Ohio, was guest speaker.

(Photos courtesy A. T. Myskowski, Naval Research Laboratory, Washington, D. C.)



level, is increasing rather slowly.

Following dinner and an entertainment program under direction of James Thomson, Continental Foundry & Machine Co., East Chicago, Ind., the technical chairman of the evening, H. J. Jacobson, Industrial Pattern Works, Chicago, assumed charge of the meeting. Mr. Jacobson, chairman of the chapter's Pattern division, introduced Mr. Pfeiffer.

The speaker, member of the Executive Committee, A.F.A. Patternmaking Division, analyzed methods for production of internally sound and dimensionally accurate castings.

Recommended were: Use of standard equipment and procedure —avoiding special methods—wherever possible; making of working models to illustrate assembly so that workers can visualize relationship of their work in cases of complicated patterns and core boxes; and furnishing of bidders with standard estimate sheets on which specifications are stated clearly, when patterns are to be purchased.

The latter practice will simplify estimating of costs since all bidders will be working to the same specifications, Mr. Pfeiffer pointed out.

Earlier in the month, the chapter held its Annual Ladies' Night party at the Stevens Hotel, with approximately 350 couples attending. The event was adjudged a success matching those of previous years. Chairman and secretary, respectively, of the entertainment committee in charge were: E. J. Cullinan, Western Foundry Co., Chicago, and H. E. Cullen, Carnegie-Illinois Steel Corp., Chicago.

Canton District

N. E. Moore
Wadsworth Testing Laboratory
Chapter Reporter

"Old timers" were honored at the February 21 dinner meeting of the Canton District chapter, at Mergus Restaurant, Canton, Ohio. Feature of the evening's program was presentation of 50 year pins by past Chapter Chairman K. F. Schmidt, United Engineering & Foundry Co., Canton.

Those saluted for 50 or more years service to the foundry industry were: John Ward and Frank Lang, of American Steel Foundries, Alliance, Ohio; Ed Fletcher, Harry Wisner, John Boyle, William Devine, Harry Towns, William Apgar and John Barnett, Machined Steel Castings Co., Alliance; George Hunter, Fred Leedham, Tom Betz and Robert Hug, United Engineering & Foundry Co.; John Bellinski and Theodore Dubs, Canton Pattern & Mfg. Co., Canton; William Potts, William Mullet, Charles Geiger and Ollie Shaeffer, Deming Co., Salem, Ohio; Charles McCafferty and Watson Johnson, Pitcairn Co., Barberton, Ohio; John Bonnot, with the longest (63 years) service record of those present, and Cyrus Jackson, Bonnot Co., Canton; Alfred Vose, Union Metal Mfg. Co., Canton; and Christian Kratt, Lectromelt Steel Castings Co., Barberton.

Following the ceremonies, the meeting was divided into sections for round table discussions. Group leaders were: cast iron, C. W. Traynor, Union Metal Mfg. Co.; steel, Carl Fornwalt, Atlantic Foundry Co., Akron, Ohio; pattern, G. W. Simes, American Steel Foundries; nonferrous, Charles McCafferty; time and motion study, M. B. Hoffman, Norris Elliot Co., Columbus, Ohio.

A group of "Old Timers," among those honored at the February meeting of the Canton District chapter. (Front row, left to right): Tom Betz and George Hunter, United Engineering & Foundry Co., Canton, Ohio; C. A. Jackson and John Bonnot, Bonnot Co., Canton; Ed Fletcher, Machined Steel Castings Co., Alliance, Ohio; John Bellinski, Canton Pattern & Mfg. Co., Canton; Harry Towns and William Devine, Machined Steel Castings Co. (Back row, left to right): Fred Leedham, United Engineering & Foundry Co.; William Potts, Deming Co., Salem, Ohio; Robert Hug, United Engineering & Foundry Co.; Theodore Dubs, Canton Pattern & Mfg. Co.; John Boyle and Harry Wisner, Machined Steel Castings Co.; Alfred Vose, Union Metal Mfg. Co., Canton; Watson Johnson and C. P. McCafferty, Pitcairn Co., Barberton, Ohio.

Eastern Canada-Newfoundland

G. D. Turnbull
Shawinigan Foundries, Ltd.
Chairman, Publicity Committee

Foundry experts answered interesting questions on all phases of foundry activities in the "Quiz" program conducted by the Eastern Canada and Newfoundland chapter, holding its March meeting at the Mount Royal Hotel, Montreal, Que. Chapter Chairman G. E. Tait, Dominion Engineering Works, Lachine,

Que., presided at the business meeting.

"Quiz-master" Bernard Collitt, Jenkins Bros., Ltd., Montreal, served as chairman for the technical program and handed out to members of the board of experts questions which had been sent in by chapter members and others in the industry.

Comprising the board were: W. T. Shute, Canadian Car & Foundry Co., Ltd., Montreal; A. J. Moore, Montreal Bronze, Ltd., Montreal; J. C. Converse,* Crane, Ltd., Montreal; Chapter Director A. E. Cartwright, Robert Mitchell Co., Ltd., St. Laurent, Que.; Edward Cyr, Industrial Pattern & Foundry Works, Montreal; and E. C. Winsborrow, Shawinigan Foundries, Ltd., Shawinigan Falls, Que.

General discussion interspersed the answering of questions, which concerned aspects of iron, steel and nonferrous casting. Consensus of opinion was that the meeting was an outstanding success to the extent that it very likely will become an annual event.

*Author of the technical paper on "Sand Control in the Bronze Foundry," in this issue.

Chapter Chairman J. M. Robb (extreme left), Hickman Williams & Co., Philadelphia, chats with Chapter Director E. C. Troy, Dodge Steel Co., Philadelphia, speaker of the evening, at the February meeting of the Philadelphia chapter. Right, chapter members give close attention to the discussion of core and molding sands.

Michiana

H. B. Voorhees
Dodge Mfg. Corp.
Chapter Director

FIRST MEETING held in Michigan City, Ind., by the Michiana chapter took place March 5, at the Spaulding Hotel, with an attendance of more than a hundred members and guests. Arrangements for the meeting were handled by Chapter Director J. H. Miller, Josam Products Foundry Co., Michigan City.

A shovel and a rammer, cast in miniature by Lew Minix, Josam Products Foundry Co., to be used in calling chapter meetings to order, were presented by Mr. Miller to Chapter Chairman W. V. Johnson, Oliver Farm Equipment Co., South Bend, Ind. Another sample of Mr. Minix's work, a cast one-piece cup, saucer and spoon, was presented as a door prize.

Speaker of the evening was F. G. Steinebach, *The Foundry,* Cleveland, who discussed "Progress in Castings." Technical developments in the foundry industry during the war and problems of the immediate market, were considered by the speaker, who recommended continued standardization of methods for the production of better, more uniform castings.

Northwestern Pennsylvania

E. M. Strick
Erie Malleable Iron Co.
Chapter Vice-Chairman

AN ENTHUSIASTIC GROUP of approximately 100 foundrymen attended the Feb. 25 meeting of the Northwestern Pennsylvania chapter, at the Moose Club, Erie, Pa. "Sound Cupola Practice" was discussed by T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio, member of the Steering Committee, A.F.A. Gray Iron Division.

Mr. Barlow commented that standard practice is not generally applied to cupola operation and described conditions in many plants in which cupolas of identical construction are not operated in the same manner. The speaker attributed this inconsistency to failure to analyze the piping and general hookups of the units.

During the question and answer period, led by K. T. Guyer, Cascade Foundry Co., Erie, Mr. Barlow explained many aspects of daily cupola operation.

Chapter Vice-Chairman E. M. Strick, Erie Malleable Iron Co., Erie, presided at the meeting. Chapter Director D. J. James, chairman of the local foundry exhibit to be held at the Erie YMCA following the 50th Anniversary Convention, reported on progress of arrangements.

Chapter activities for the month included a special meeting, Feb. 18, at the Arlington Hotel, Oil City, Pa., of a group of chapter members and friends from the Venango County area. Chapter Director T. H. Beaulac, Chicago Pneumatic Tool Co., Franklin, Pa., was presiding officer.

A discussion of "Patterns for Production" was presented by J. E. Gill, Lake Shore Pattern Works, Erie. The speaker described the characteristics of pine, mahogany and metal patterns, and indicated considerations governing choice of material. Exceptional interest in the subject was demonstrated by those present and questions raised in the general discussion period concerned aspects ranging from wood finishes to comparative merits of aluminum and wood plates.

Philadelphia

C. L. Lane
Florence Pipe Foundry & Machine Co.
Chapter Director

RESEARCH INTO BASIC PRINCIPLES involved in sand compounding was recommended by E. C. Troy, Dodge Steel Co., Philadelphia, who discussed "Core and Molding Sands" before the February meeting of the Philadelphia chapter.

Mr. Troy, a director of the Philadelphia chapter and member of the Committee on Heat Transfer, A.F.A. Foundry Sand Research Project, stated that sand control as practiced proves inadequate since it is based on day to day results rather than understanding of necessary and desirable properties. Such practice will

CHAPTER MEETINGS

APRIL-MAY

April 18

Twin City

Curtis Hotel, Minneapolis
G. K. Dreher
Ampco Metals, Inc.
"The Use of Bronze"

Canton District

Mergus Restaurant, Canton
Round Table Meeting

Detroit

Rackham Educational Memorial
Round Table Meeting

April 19

Toledo
Toledo Yacht Club

April 22

Central Ohio

Chittenden Hotel, Columbus
J. A. Kayser
Laclede-Christy Clay Products Co.
"Foundry Refractories"

Northwestern Pennsylvania

Moose Club, Erie
Quiz Program

April 26

Chesapeake

Engineers Club, Baltimore, Md.
"Foundry Safety"

May 2

Saginaw Valley

Fischer's Hotel, Frankenmuth, Mich.
Morris Bean
Antioch Foundry
"Precision Casting"

May 3

Western New York

Hotel Touraine, Buffalo
A. C. Den Breejen
Hydro-Blast Corp.
"Practical Foundry Sand Problems"

Ontario

Royal York Hotel, Toronto
Annual Meeting

May 10

Wisconsin

Hotel Schroeder, Milwaukee
Old Timers and Apprentices

May 14

Texas

Houston

Rochester

Hotel Seneca
Annual Meeting

May 13

Cincinnati District

Engineering Society Headquarters
Cincinnati
Hiram Brown
Aluminum Industries, Inc.
"Light Metals"

May 21

Twin City

Curtis Hotel, Minneapolis
W. A. Hambley
Allis-Chalmers Mfg. Co.
"Blows and Shrinks"

May 16

Detroit

Rackham Educational Memorial
Round Table Meeting

Northern California

Hotel Alameda, Alameda
"Non-Ferrous Castings"

May 22

Central Indiana

Athenaeum, Indianapolis
J. H. Smith
Accessories Group, GMC
Stuart Martin
Saginaw Malleable Iron Div.
"Progress with Better Methods and Motion Study"

May 23

Canton District

Mergus Restaurant, Canton
Zigmond Madacey
Caterpillar Tractor Co.
"Core Blowing"

Northeastern Ohio

Cleveland Club
Old Timers' Night

May 21

Connecticut Non-Ferrous Foundrymen's Association

Indian Hill Country Club
New Britain, Conn.

continue, Mr. Troy said, until research brings about a more thorough comprehension of basic principles.

Technical Chairman for the meeting was C. W. Mooney, Jr., Olney Foundry Div., Link Belt Co., Philadelphia.

Detroit

C. J. Rittinger
Riley Stoker Corp.
Chapter Reporter

ROUND TABLE DISCUSSIONS of gray iron, brass and bronze, and foundry supplies were featured at the February meeting of the Detroit chapter, in Rackham Educational Memorial, Detroit.

The gray iron session heard a discussion of "Addition Agents in Modern Cast Iron," by V. A. Crosby, Climax Molybdenum Co., Detroit, member of the Executive Committee, A.F.A. Gray Iron Division. Mr. Crosby presented data compiled by various plants and described the effects of late inoculations on iron. Discussion leader was H. H. Wilder, Eaton Mfg. Co., Detroit, who is chairman of the Committee on Chill Tests, Gray Iron Division.

"Sand in the Brass Foundry" was the subject of E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit, before the brass and bronze group. Mr. Woodliff, recognized authority on properties and performance of sand in all types of foundries and Chairman, A.F.A. Sand Shop Operation Course Committee, specifically considered application of the material in brass casting techniques. Chapter Director J. P. Carritte, Jr., True Alloys, Inc., Detroit, presided as discussion leader.

A board of experts handled the "Question Box on Supply Problems" for the foundry supplies meeting, with C. D. Yahne, Wolverine Foundry Supply Co., Detroit, acting as discussion leader.

New England Association

M. A. Hosmer
Hunt-Spiller Mfg. Corp.
Association Reporter

HOLDING ITS regular monthly meeting at the Engineers Club, Boston, Mass., on February 13, the New England Foundrymen's Association considered proper methods of loading, storing and transporting materials. M. W. Potts, Eastern Industrial Sales Co., presented a paper on "Materials Handling."

Mr. Potts defined his subject as "the lifting or the shifting of any material regardless of its size, form or weight," and stated that handling constitutes 85 per cent of production costs. A sound movie illustrating loading of cars and ships, piling for storage, and transporting materials was shown.

Preceding the program was a short business meeting, with Association President B. W. Hagerman, Rice-Barton Corp., Worcester, Mass., presiding.

Canton District Chapter President H. G. Robertson, American Steel Foundries, Alliance, Ohio, congratulates John Bonnot, Bonnot Co., Canton, Ohio, as the man with the longest service record among "Old Timers" honored at the chapter's February meeting.

Texas

R. B. Mumford
McArdle Equipment Co.
Chairman, Publicity Committee

"CORRECTION OF FOUNDRY WASTE" was the timely subject of A. J. Edgar, Gray Iron Founders' Society, Washington, D. C., before the Texas chapter's regular monthly meeting, Feb. 15, at the Golfcrest Country Club, Houston, Texas.

Mr. Edgar, member of the Executive Committee, A.F.A. Gray Iron Division, stressed the importance of control of all foundry operations. Use of correct quantities gives maximum efficiency in cupola operation, eliminating direct waste and materially reducing losses through scrap castings, he observed.

The speaker also recommended: Control in preparation of core sand mixes, particularly accurate measurement of components; closer inspection of assembled cores to prevent scrap losses; selection and proper mixing of the right molding sand; maintenance of equipment in good condition; and proper design of gates and risers after analysis of each job.

Instruction and supervision of inexperienced help involved in shakeout and cleaning will hold to a minimum the waste apparent in such operations, Mr. Edgar stated.

Cincinnati District

W. H. Hoppenjans, Jr.
Star Foundry Co.
Chapter Secretary

ALL PAST CHAPTER CHAIRMEN of the Cincinnati District chapter attended the meeting dedicated in their honor, on Feb. 11, at Engineering Society Headquarters, Cincinnati. A large delegation of students and faculty members from Withrow High School, Cincinnati, also were present as guests of the chapter in the interests of furthering knowledge of foundrymen and foundry operations among educational groups.

Chapter Vice-President Joseph Schumacher, Hill & Griffith Co., Cincinnati, served as chairman of the meeting. Mr. Schumacher presented H. K. Ewig, Cincinnati Milling Machine Co., Oakley, Ohio, a past chapter chairman, who welcomed the guests and explained the objectives of A.F.A., referring briefly to its activities.

Principal speaker of the evening was W. B. George, R. Lavin & Sons, Chicago. Mr. George, chairman of the Subcommittee on Yellow Brass, A.F.A. Brass and Bronze Division, directed his discussion of "Brass and Bronze Castings" toward clarification of the principles of directional solidification and shrinkage prevention in castings of such alloys.

Western New York

L. A. Merryman
Tonawanda Iron Corp.
Chapter Secretary

RESPONSIBILITY FOR safety and efficiency should be placed on individual workers, M. P. Schemel, Symington-Gould Corp., Depew, N. Y., recommended in a discussion of "Modern Cleaning Room Practice," before the March meeting of Western New York chapter, at the Hotel Touraine, Buffalo, N. Y.

Chapter Chairman A. H. Suckow, Symington-Gould Corp., was presiding officer.

Mr. Schemel, a member of the chapter, based his remarks upon years of practical experience in supervising steel castings cleaning room operations, and covered his subject in a thorough manner.

The speaker suggested that workers should care for their own equipment as a safety measure. Chippers, for instance, should sharpen their own chisels to suit the particular operation and individual method. Similarly, grinders should be responsible for care and changing of wheels, and keeping careful records of wheel life to determine grinding costs, Mr. Schemel advised.

Methods of removing gates, risers and flashings were considered; as were sandblasting, heat treating, welding, straightening and inspection. Recommendations included: routing castings through the cleaning room in a straight line, thus reducing handling costs; cleaning a few castings from the previous day's heat as early as possible, in order to discover and correct defects which might be caused by foundry trouble; and mixing of sand with shot to reduce static in sandblasting operations.

Northern California

C. R. Marshall
Chamberlain Co.
Chairman, Publicity Committee

FOUNDRY EDUCATION was the theme of the Northern California chapter's March meeting at the Engineers' Club, San Francisco, with Chapter President Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco, presiding.

Members heard a clear explanation of the workings of the G.I. Bill of Rights in connection with apprentice training programs and existing labor contracts, presented by W. J. Logue, Area Supervisor, Apprentice Training Service, U. S. Dept. of Labor.

Principal speaker of the evening was Fred G. Sefing, International Nickel Co., New York, who is Chairman of the Executive Committee, A.F.A. Committee on Cooperation with Engineering Schools. "A Study of Molding Methods to Produce Sound Castings" was the topic of Mr. Sefing, who was introduced by Chapter Director A. M. Ondreyco, Vulcan Foundry Co., Oakland, Calif., serving as the program chairman.

The speaker prefaced the main body of his remarks with three recommendations: (1) In attacking any foundry problem, attempt to simplify your thinking; (2) remember that regardless of the metal being poured, the same principles apply; and (3) keep in mind that sound castings cost money—but the buyer's attitude should be that any extra cost for the production of sound castings is more than offset by decrease in number of rejects.

Mr. Sefing then considered problems common to all foundries: cleanliness of metal, which demands precautions to prevent dust and slag from entering the mold cavity; proper design, through which many other problems are simplified; shrinkage, which must be anticipated through understanding and practice of the theory of controlled progressive solidification; and porosity, generally caused by gas pressure, in which case adequate venting, good cores and fast pouring are indicated.

Members demonstrated considerable interest in the subject during the discussion period.

Earlier in the meeting, Harris Donaldson, Brumley-Donaldson Co., Los Angeles, membership committee chairman, introduced new members: F. J. Biava, E. L. Fetters, C. P. Sobey, F. A. Warn and W. J. Weber, all of U. S. Navy Yard, Mare Island; J. L. DeMello, Pacific Steel Casting Co., Berkeley, Calif.; and William Skinner, Jr., Vulcan Foundry Co.

Among the guests at the speaker's table were A. G. Zima, International

Speaker's table group at the March meeting of the Northern California chapter. Left to right: Chapter Director H. A. Bossi, H. C. Macaulay Foundry Co., Berkeley, Calif.; W. J. Logue, Apprentice Training Service, U. S. Dept. of Labor; Chapter President Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco; F. G. Sefing, International Nickel Co., New York, principal speaker of the evening; Chapter Director A. M. Ondreyco, Vulcan Foundry Co., Oakland, Calif.; A. G. Zima, International Nickel Co., Los Angeles; and Chapter Secretary J. F. Aicher, E. A. Wilcox Co., San Francisco.

(Photo Courtesy Enterprise Engine & Foundry Co.)

Nickel Co., Los Angeles, and C. C. Adams, newly appointed secretary, Northern California Foundrymen's Institute.

Metropolitan

C. J. Law
Worthington Pump & Machinery Corp.
Chapter Director

CHECK PRACTICES workers use against known correct practice, to eliminate one cause of casting defects, D. Frank O'Connor, American Saw Mill Machine Co., Hackettstown, N. J., told 75 members of the Metropolitan chapter at the March 4 meeting, in the Essex House, Newark, N. J.

Mr. O'Connor, who is Chairman, A.F.A. Brass and Bronze Division, referred to the tendency of workers to drift away from practices known to be right. He stated that causes of defects in bronze and ferrous metal castings can be established by going into the foundry, to the foreman in charge of the work and the men under his direction—and checking methods employed.

Defects in magnesium were discussed in a paper on "Causes and Control of Porosity in Magnesium Alloy Sand Castings," prepared by M. E. Brooks, Dow Chemical Co., Bay City, Mich., and read in the author's absence by B. G. Harr, of the same firm.

Mr. Brooks, member of the Executive Committee, A.F.A. Aluminum and Magnesium Division, noted that the two causes of porosity in magnesium alloys are microshrinkage and gas. Gating and feeding improperly may cause microshrinkage, and care must be taken to avoid turbulence, he observed.

Composition of the alloy—as reflected in its freezing range—affects porosity, Mr. Brooks reported. Also considered were elimination of hydrogen gas through preheating of scrap used, avoidance of dampness in equipment, and protection of melts from atmosphere where humidity is high. Use of carbon to eliminate gas and refine melts was recommended.

The remarks of the two speakers were followed by a discussion period, with A. V. Lorch, White Metal Rolling & Stamping Corp., Brooklyn, N. Y., presiding.

At the business session of the meeting, Chapter Chairman H. A. Deane, American Brake Shoe Co., New York, announced appointment to the chapter nominating committee of three members: T. D. Parker, Climax Molybdenum Co., N. Y.; J. Reed, R. Hoe & Co., Inc., Dunellen, N. J.; and H. C. Harris, Mack Mfg. Corp., New Brunswick, N. J.

(Photo Courtesy Enterprise Engine & Foundry Co.)

Bill Clark (seated), Enterprise Engine & Foundry Co., San Francisco, greets John Russo, Pacific Graphite Works, Oakland, Calif., at the March meeting of the Northern California chapter. Milton Oakes (left), American Manganese Steel Div., Oakland; and Chapter Secretary Fred Aicher, E. A. Wilcox Co., San Francisco, look on

Eastern Canada - Newfoundland

G. D. Turnbull
Shawinigan Foundries, Ltd.
Chairman, Publicity Committee

GROUP DISCUSSIONS featured the meeting of the Eastern Canada-Newfoundland chapter at Mount Royal Hotel, Montreal, Quebec, February 8, and record attendance together with interest displayed in discussion periods attested to the popularity of this type of meeting.

Short informal papers were presented before sections on iron and steel, non-ferrous and patternmaking. J. Grieve, Dominion Engineering Works, Ltd., Lachine, Quebec, presided at the iron and steel section. "Feeding Iron Castings" was the topic of W. Bradley, Dominion Engineering Works, Ltd.; while W. T. Shute, Canadian Car & Foundry Co. Ltd., Montreal, discussed "Pressure Feeding Steel Castings."

The non-ferrous group meeting was under the chairmanship of A. J. Moore, Montreal Bronze, Ltd., Montreal. Discussion leaders were H. W. Bennett, Dominion Engineering Works, Ltd., who spoke on "Gates and Risers," and C. J. Converse, Crane, Ltd., Montreal, who discussed "Sand Control in the Bronze Foundry*."

At the third group meeting, with W. Seeds, Western Pattern Works, Montreal, presiding, "Composition Matchplate Patterns" was the subject of C. C. Brisbois, Robert Mitchell Co. Ltd., Montreal.

**Paper published in this issue.*

Central Illinois

C. W. Wade
Caterpillar Tractor Co.
Chapter Secretary

REPORTING ON GERMAN manufacturing methods for heavy production equipment before the February meeting of the Central Illinois chapter, at the Jefferson Hotel, Peoria, Mr. Lloyd Ely, Caterpillar Tractor Co., Peoria, stated that the Germans never achieved mass production comparable to that in the United States —in spite of the fact that their experts had studied American methods.

Differences between apprenticeship in Germany and in this country were described by the speaker, who told the members that fathers of

The speaker's table at the March meeting of the Central Indiana chapter. Left to right: Chapter Chairman R. S. Davis, National Malleable & Steel Castings Co., Indianapolis; speaker of the evening, G. E. Clark, Cummins Engine Co., Columbus, Ind.; and Chapter Vice Chairman J. P. Lentz, International Harvester Co., Indianapolis, technical chairman for the meeting.

apprentices in the former nation pay for the privilege of having their sons serve a specified period of apprenticeship. Further, the apprentice must render complete obedience to all commands.

Mr. Ely, who had been chosen by the U. S. Corps of Engineers to inspect enemy installations after V-E Day, was introduced by F. W. Shipley, Caterpillar Tractor Co., acting as program chairman. Chapter Chairman L. E. Roby of the same firm presided.

"Synthetic Sand in the Small Foundry" was the topic of the second speaker of the evening, E. W. Claar, Eastern Clay Products, Inc., Eifort, Ohio. Mr. Claar defined synthetic sand and discussed the role of bonding clays in producing desirable properties in sand mixtures.

Central Indiana

B. P. Mulcahy
Citizens Gas & Coke Utility
Chapter Historian

CHOOSING THE SUBJECT, "Alloys in Cast Iron," G. E. Clark, Cummins Engine Co., Columbus, Ind., addressed the March meeting of the Central Indiana chapter, in the Athenæum, Indianapolis.

Discussing specifications for cast iron, the speaker, member of the Committee on High Temperature Properties of Cast Iron, A.F.A. Gray Iron Division, stated that chemical specifications must be correlated with physical properties to obtain material suitable for the purpose under consideration.

Discussion which followed Mr. Clark's remarks was developed under the guidance of Chapter Vice-Chairman J. P. Lentz, International Harvester Co., Indianapolis, who served as technical chairman.

Connecticut Non-Ferrous

L. G. Tarantino
Niagara Falls Smelting & Refining Corp.
Association Secretary

HOLDING ITS February meeting at the Hotel Taft, New Haven, Conn., the Connecticut Non-Ferrous Foundrymen's Association heard a discussion of "Recommended Practices for Crucible Use," presented by L. A. Behrendt, Joseph Dixon Crucible Company, Jersey City, New Jersey.

Members demonstrated keen interest in the subject during a question and answer period following the talk.

Philadelphia

E. C. Troy
Dodge Steel Co.
Chapter Director

"NON-FERROUS NIGHT," under the sponsorship of Dr. G. H. Clamer, Ajax Metal Co., Philadelphia, past A.F.A. National President, was observed by approximately 300 guests and members attending the March meeting of the Philadelphia chapter, at Franklin Institute, Philadelphia.

Examples of the handicraft of Japanese non-ferrous foundrymen were exhibited by F. T. Chestnut, Ajax Metal Co., who related his experiences in visiting Japan as a member of the U. S. Navy Technical Mission. Mr. Chestnut described destruction wrought by Allied bombings, and exhibited a fragment of radioactive tile taken from the Hiroshima area.

The first speaker's remarks served as a prelude to discussion of atomic energy which followed. At the request of Chapter Chairman J. M. Robb, Hickman Williams & Co., Philadelphia, who also expressed the

Enjoying the February meeting of the Northern California chapter (left to right): J. B. Morse, Del Monte Properties Co., San Francisco; Chapter Vice-President Richard Vosbrink, Berkeley Pattern Works, Berkeley; Chapter President Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco; speaker of the evening D. L. Mason, Stanford University, Palo Alto; Chapter Director A. M. Ondreyco, Vulcan Foundry Co., Oakland; and National Director S. D. Russell, Phoenix Iron Works, Oakland.

(Photo courtesy Enterprise Engine & Foundry Co.)

Southern California chapter March meeting was held in Roger Young Auditorium, Los Angeles. At the speaker's table (left): James Eppley, Kinney Iron Works, Huntington Park, Calif.; C. C. Pendrell, Haynes-Stellite Co., Los Angeles, speaker of the evening; F. S. Boericke, Haynes-Stellite Co.; and Chapter President R. R. Haley, Advance Aluminum & Brass Co., Los Angeles. Right, among the audience of more than 100 (left to right): P. E. Crow and S. R. Kimberly, both of Equipment Engineering Co., Los Angeles; Paul Siechert and Glen Hopping, Alhambra Foundry Co. Ltd., Alhambra, Calif.; Bill Palmer, Macklin Co., Los Angeles; C. E. Homer, Kinney Iron Works; C. G. Emery, Macklin Co.; and F. S. Mittl, Kinney Iron Works.

chapter's appreciation for the excellent arrangements of the evening, Dr. Clamer served as technical chairman and introduced Dr. R. K. Marshal, associate director, Franklin Institute.

Dr. Marshal presented a stirring address on the wonders of atomic physics. Foundrymen were awed by the speaker's comprehensive portrayal of the economic and social implications inherent in the mastery of atomic energy. Dr. Marshal stressed the destructive and constructive potentialities of nuclear physics.

Northern California

C. R. Marshall
Chamberlain Co.
Chairman, Publicity Committee

MODERN SAND TESTING techniques were discussed and demonstrated before the February meeting of the Northern California chapter at the Hotel Alameda, Alameda, Calif., by D. L. Mason, instructor in foundry practice, Stanford University, Palo Alto, Calif.

Chapter Director A. M. Ondreyco, Vulcan Foundry Co., Oakland, Calif., acting as program chairman, introduced the speaker. Mr. Mason pointed out that the foundry industry has come a long way from the old processes of feeling, tasting, smelling and blowing through sand to test its suitability for making molds. He described and operated each of several types of apparatus; and explained the practical application of results obtained from the tests toward the manufacture of better castings.

A panel of sand committee members, headed by committee chairman G. W. Stewart, Pacific Brass Foundry of S. F., San Francisco, took part in the discussion period. Questions raised concerned such aspects as: place of the microscope in study of sand grain arrangement and analysis of casting defects; pieces of sand testing equipment necessary to the small foundry; and design and use of a small 2500° F. oven furnace for testing cores.

At the dinner preceding the program, Chapter President Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco, announced the formation of a new Educational Committee under the chairmanship of National Director S. D. Russell, Phoenix Iron Works, Oakland.

Southern California

Jas. B. Morey
International Nickel Co. Inc.
Chairman, Publicity Committee

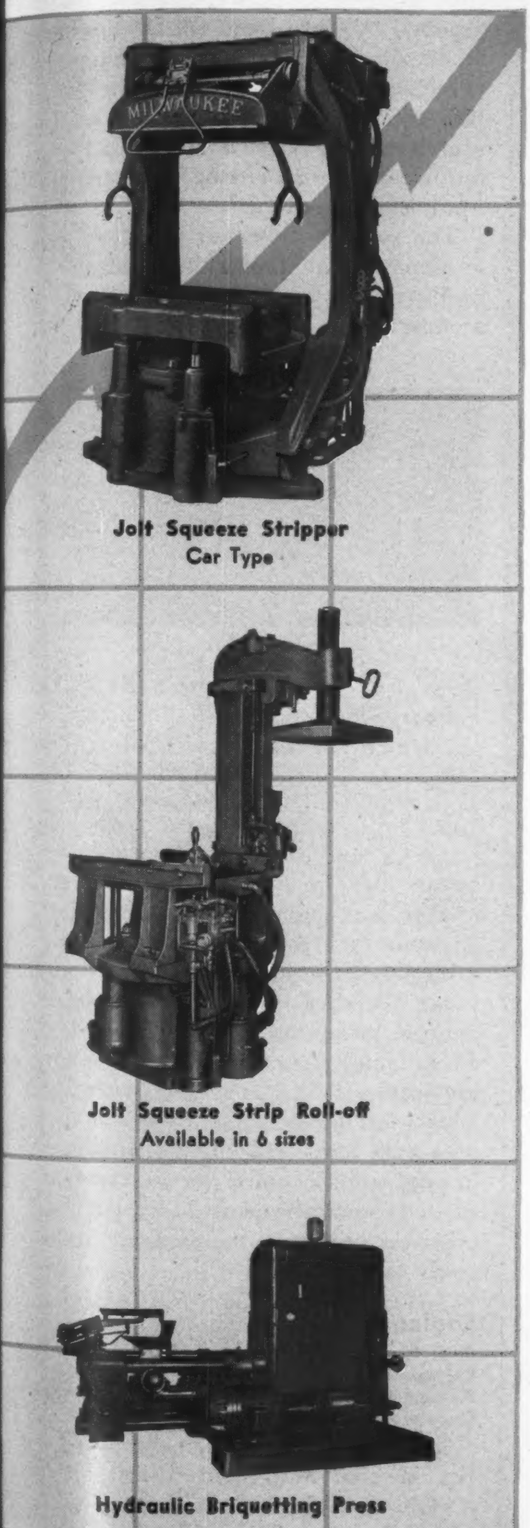
SAVING IN MAN-HOURS through use of the lost-wax process and consequent elimination of machining

(Continued on Page 204)

Speaker of the evening at the February meeting of the Northern California chapter was D. L. Mason, Stanford University, Palo Alto, shown demonstrating sand testing equipment.

(Photo courtesy Enterprise Engine & Foundry Co.)

WITH MILWAUKEE MOLDERS



Jolt Squeeze Stripper
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Available in 6 sizes

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THERE'S A MODERN, HIGH-SPEED MILWAUKEE MOLDER FOR EVERY MOLDING REQUIREMENT

The lid is off!! Now, "sky is the limit" as far as foundry production is concerned. For those new, streamlined Milwaukee Machines enable you to step up mold production to an amazing degree. They are designed to modernize molding methods, speed up the job and at the same time retain the highest standards of quality.

In the complete MILWAUKEE line, there's a model to meet every molding requirement. And every machine is designed and built to take hard, everyday punishment. Steel castings and alloy steels are used where stress is applied. Close-grained, high tensile grey iron is used wherever wear occurs. Instead of links and levers, rigid integral members are employed for alignment. Hardened pins and bushings serve as guides. Correct lubrication is provided. All parts are accurately machined to close tolerances. Adjustments are very accessible and easy to make.

Call in a MILWAUKEE Foundry Engineer

Every engineer at Milwaukee Foundry Equipment Co. is a practical, seasoned foundryman, familiar with all phases of the industry (pattern making, foundry engineering, foundry operation, etc.) This broad experience enables him to study your molding and core making problems intelligently, and arrive at a solution that is both practical and economical.

CLEVELAND, OHIO—MAY 6th to 10th

Foundry Equipment Co

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Chapter Activities

(Continued from Page 182)

and finishing operations, was emphasized by C. C. Pendrell, Haynes-Stellite Co., Los Angeles, in a talk on "Precision Castings," before nearly 100 members and guests at the March meeting of the Southern California chapter, in Roger Young Auditorium, Los Angeles.

• The speaker presented a full description of the process as applied by his firm, indicating the startling accuracy with which various alloy

A group from Torrance Brass Foundry, Torrance, Calif., attending the March meeting of the Southern California chapter. Left to right: Jhan Van Heil, F. Harwood Clark and E. E. McVicar.

metals may be cast to size within .005-in. was reported possible when all steps in making of patterns are carefully performed.

Mr. Pendrell stated that results indicate nickel and cobalt base, and all austenitic stainless alloys are most applicable to the precision process, which—while not intended to compete with screw machine operations in production of small parts—is considered admirably suited for parts otherwise difficult to produce, or costly to machine.

Saginaw Valley

J. J. Clark
Saginaw Malleable Iron Div.
General Motors Corp.
Chapter Reporter

ENUMERATING DESIRABLE properties in core and mold washes, J. A. Gitzen, Delta Oil Products Co., Milwaukee, reminded members of the Saginaw Valley chapter, holding their March meeting at Frankenmuth, Mich., that the best wash will not perform satisfactorily if applied to unsuitable base sand.

The speaker, Chairman of the

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Chapter Activities

(Continued from Page 204)

Subcommittee on Core Washes, A. F.A. Foundry Sand Research Project, presented a number of recommendations for making and applying washes. Some aspects considered were: manufacturer's recommendations—which should be followed, since addition of other materials may destroy effectiveness of the wash; maintenance of proper consistency; proper core surfaces; application and penetration; and drying.

New England Association

M. A. Hosmer
Hunt-Spiller Mfg. Corp.
Association Reporter

MECHANIZED FOUNDRY techniques held the attention of 120 members and guests of the New England Foundrymen's Association attending the March meeting, at the Engineers' Club, Boston, as H. G. Schlichter, Beardsley & Piper Co., Chicago, discussed "Sandslinger Operations."

The speaker supplemented his remarks with an interesting motion picture illustrating applications of the equipment in manufacture of castings throughout the foundry industry.

Mr. Schlichter pointed out that mechanical ramming of the mold is the heart of the process, and that resulting hardness of the mold depends upon type of mold, sand characteristics and operation of the sandslinger. The speaker presented recommendations in regard to permeability and green strength of sand and aspects of its preparation; and commented upon skill required to operate the units, wear and tear on patterns, comparison of speed of machine and hand ramming, and maintenance costs.

Central Ohio

K. W. Whitlatch
Aetna Fire Brick Co.
Chapter Secretary

GUEST SPEAKER for the February meeting of the Central Ohio chapter, at the Chittenden Hotel, Columbus, Ohio, was B. P. Mulcahy, Citizens Gas & Coke Utility, Indianapolis, a Chapter Director of the Central Indiana chapter.

Discussing "Cupola Operations

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Chapter Activities

(Continued from Page 205)

and Foundry Coke Characteristics," Mr. Mulcahy pointed out that cupola charges are melted by combustion gases rather than direct contact with the coke. Illustrating his remarks with slides, the speaker traced the route of gases and explained aspects of melting requirements and air consumption. Importance of coke size in cupola control was stressed.

St. Louis District

L. H. Horneyer
Chapter Secretary-Treasurer

ASPECTS OF THE CURRENT economic picture were discussed before the February meeting of the St. Louis District chapter, at the DeSoto Hotel, St. Louis, by J. H. Van Deventer, *Iron Age,* New York, whose topic was "Let's Release the Brakes."

Chapter Director L. A. Kleber, General Steel Castings Corp., Granite City, Ill., introduced the speaker. A lively discussion and question period followed Mr. Van Deventer's comments.

W. W. Zeis, Midwest Foundry Supply Co., Edwardsville, Ill., introduced new members, and reported that the chapter membership had reached 255. Chapter Chairman W. E. Illig, Banner Iron Works, St. Louis, drew the attention of the members to the booklet *Foundry Sands and Mold Materials,* published by the Northern California chapter; and also reported on the plans of a group of French engineers to visit St. Louis during a tour of American foundries.

Ontario

G. L. White
Westman Publications, Ltd.
Chapter Secretary-Treasurer

SPIRITED DISCUSSION of major developments in gating and risering practice featured the February meeting of the Ontario chapter at the Royal York Hotel, Toronto. H. F. Taylor, Naval Research Laboratory, Washington, D. C., presented a discussion of such practice in ferrous and non-ferrous casting.

Mr. Taylor, who is active in a number of National committees of

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Chapter Activities
(Continued from Page 207)

the A.F.A. Foundry Sand Research Project, considered such aspects as: reduction of size of risers, use of insulating and exothermic materials, knock-off risers, and utilization of atmospheric pressure in risers.

Chapter Chairman T. D. Barnes, Don Barnes Foundry Supplies & Equipment, Hamilton, Ont., presided at the meeting. The speaker was introduced by Chapter Director J. Dalby, Wilson Brass & Aluminum Foundries, Ltd., Toronto.

Southern California

Jas. B. Morey
International Nickel Co.
Chairman, Publicity Committee

FLUOROSCOPIC INSPECTION in quality control of aircraft castings was reviewed before the February meeting of the Southern California chapter, in Roger Young Auditorium, Los Angeles. Speaker of the evening was Tom Piper, Northrop Aircraft, Inc., Hawthorne, Calif., who discussed "The Fluoroscope and Shrinkage."

Mr. Piper, chief materials and process engineer for his firm, considered foundry problems as related to quality requirements of aircraft castings. He commented upon the rejection by aircraft manufacturers of thousands of castings, through lack of information upon which to evaluate the effect of natural inherent irregularities. This lack of information led to rejections based upon personal opinions and assumptions.

The speaker then traced the development of a formula designed to govern quality inspection and protect both foundry and purchaser from wasteful and unnecessary rejections. In concluding, Mr. Piper stressed the necessity of controlling shrinkage by a formula, so that aircraft engineers can design castings which a foundry can pour.

Saginaw Valley

J. J. Clark
Saginaw Malleable Iron Div.
General Motors Corp.
Chapter Reporter

TWO SIMPLE TESTS through which suitability of sand for foundry use

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Chapter Activities

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can be determined, were described before the Feb. 7 dinner meeting of the Saginaw Valley chapter, at Frankenmuth, Mich., by A. C. Den Breejen, Hydro-Blast Corp., Chicago.

In discussing "Practical Foundry Sand Problems," the speaker recommended heating a sample of the sand to a red heat, and cited cases in which sand "popped" and broke down, indicating unfitness for foundry use.

The second test consists of immersing a sample of the sand in an acid. Foaming and frothing, produced by chemical reaction, reveal the presence of foreign chemical compounds which affect the performance of the sand in the foundry.

Mr. Den Breejen, member of the Committee on Grading and Fineness, A.F.A. Foundry Sand Research Project, stated that the best sand is the cheapest to use as a general rule. He also discussed the importance of microscopic examination of sand.

Coffee talk of the evening was presented by Martin Firth, General Motors Research Laboratory, Detroit, who described the development of personnel training.

Western Michigan

R. W. Hathaway
Chapter Director

With an attendance figure of 100 members and guests, the Western Michigan chapter held its February meeting at the Hotel Schuler, Grand Haven, Mich., and heard Nathan Janco, Centrifugal Casting Machine Co., Tulsa, Okla., discuss "Centrifugal Castings."

Mr. Janco, member of A.F.A. National committees on centrifugal casting, presented a comprehensive discussion of his subject, illustrating casting methods with lantern slides.

The speaker recommended that jobs be thoroughly analyzed before decision is reached to use the centrifugal method. Since the main purpose in using the method is to increase metal yield through the elimination of risers and decrease of metal failures, little is gained by its application in the case of commercial castings where the yield is already high, Mr. Janco pointed out.

Foundry Personalities

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annual open-hearth conference in Chicago, April 24-26.

New members of the open-hearth executive board who will take office at the Chicago conference are: J. J. Golden, Gary Works, Carnegie-Illinois Steel Corp.; C. R. Fondersmith, American Rolling Mill Co.; G. L. VonPlanck, Columbia Steel Co., San Francisco, and D. N. Watkins, *Blast Furnace and Steel Plant*, Pittsburgh, Pa.

Gilbert J. Nock, secretary, Northeastern Ohio chapter, has announced a change in firm name. Formerly known as Nock Fire Brick Co., the company is now Nock & Sons Co., 1243 East 55th St., Cleveland, Ohio.

F. T. O'Hara, Central Brass & Aluminum Foundry, 503 So. 21st St., St. Louis 3, has announced plans to construct a one-story foundry building to be located at Clark Ave. and 22nd St., at a cost of $35,000.

W. K. Sims has been appointed exclusive sales representative in the New York City area for C. B. Hunt & Sons, Inc., Salem, Ohio, and will make his headquarters in Newark, N. J.

Metal Carbides Corp., Youngstown, Ohio, announces the opening of its branch office, warehouse and service plant, 166 Bloomfield Ave., Newark, N. J.

L. S. Cohen & Co., Inc., Chicago, Ill., smelters and refiners of brass, bronze and aluminum, announce change of the firm name to Elesco Smelting Corp.

Thomas McLaughlin, president, Eastern Stainless Steel Corp., Baltimore, Md., announces appointment of R. G. Leary as sales representative of the firm in New York City and several state counties.

W. R. Spahr has been appointed

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Foundry Personalities
(Continued from Page 210)

advertising manager of the firm and continues as editor of *The Top Notcher*.

Robert Boutigny, Chief Engineer of the Societe Stein & Roubaix, Paris, France; and **Fernand Modro,** Foundry Manager at the Ecole Superieure de Fonderie in Roubaix-Nord, France, and Director of the Fonderie de Lannoy, were recent National Office visitors. Mr. Modro and Boutigny are in this country studying American methods of foundry production and are remaining here to attend the 50th Anniversary Golden Jubilee Convention at Cleveland in May. Both are members of the American Foundrymen's Association.

L. R. Buckendale, Timken-Detroit Axle Co., has been elected president, Society of Automotive Engineers New York. **B. B. Buckendale,** Autocar Co., has been elected treasurer, Society of Automotive Engineers.

H. E. Reynolds, manager, and **M. M. Coston,** sales engineer, of the Pittsburgh sales office, Whiting Corp., have moved to new and larger quarters at: Pitt Bank Building, 5th and Liberty Avenues, Pittsburgh 22, Pa.

C. A. FitzGerald, Jr., who has been associated with the iron and steel branch of W.P.B. and the office of chief of ordnance, has been appointed sales engineer, Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.

Glen McDowell, associated since 1925 with the engineering, estimating and roll sales departments of Aetna-Standard Engineering Co., Youngstown, Ohio, has been appointed manager of roll sales.

Obituaries

Elias L. Anderson, president, Crown Iron Works Co., Minneapolis, died February 12 at San Diego, Calif. Associated with Crown Iron Works since 1887, Mr. Anderson was well known to the foundry industry. He was the father of **Clifford H. Anderson,** Chapter Director and former Chapter Chairman of the Twin City chapter.

N. C. Hilton, executive manager, Abrasive Wheel, Diamond Wheel, and Bowling Ball Departments, Raybestos-Manhattan, Inc., Manhattan Rubber Div., Passaic, N. J., died March 14, in Glen Ridge, N. J. Mr. Hilton had been with Manhattan Rubber for more than thirty years.

Charles C. Hess, works manager, Western Alloyed Steel Castings Co., Minneapolis, died at his home February 27. Mr. Hess, who was a member of the Twin City chapter, spent his lifetime in close affiliation with the foundry industry and had been associated with the Western Alloyed company for the past thirty years.

New Products

Dust Sampler

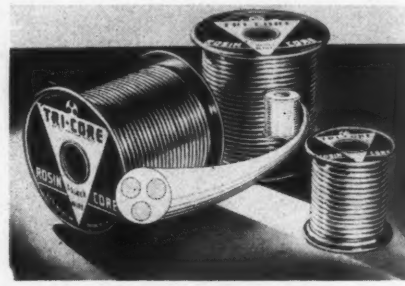
Mine Safety Appliances Co., Pittsburgh, Pa., has developed an all-glass sampling unit for use with the Mine Safety appliance midget impinger.

The all-glass sampling units consist of a flask and nozzle with a standard taper ground-glass stopper. A fritted glass bubbler also is available. This equipment is for sampling a wide variety of dusts, gases, and vapors. All-glass construction of the new impinger units permits thorough cleaning and prevents contamination or discoloration of the sample undergoing test. Air outlet in these units is placed at a maximum height, and possibility of drawing over any of the collecting fluids is practically eliminated.

The impinger nozzle orifice is fixed at the correct height and no readjustment is necessary. Each nozzle has been checked to insure a flow within 4 per cent of 1/10 cu. ft. per min. at 12 in. water vacuum.

Solder

Alpha Metals, Inc., 369 Hudson Ave., Brooklyn, N. Y., has developed a solder with three independently filled cores of pure rosin flux. This means faster soldering and elimination of dry joints, in addition to substantial savings in tin when this rosin is used.



Solder containing three rosin filled cores.

Cut-off Wheels

Bay State Abrasive Products Co., Westboro, Mass., has announced a cut-off wheel for non-ferrous metals incorporating abrasive in a cotton fibre bonding. The wheel combines greater safety, freer cutting action, minimizing the operator's fear of wheel breakage.

Cut-off wheels for cutting non-ferrous metals.

Combination Sand Conditioner and Scrap Remover

Royer Foundry & Machine Co., Kingston, Pa., has redesigned their combination sand reconditioner and scrap remover for easier handling. A strong inverted "Y" bar has been installed in the center of the unit at the top, with an eye at its upper end. This takes the place of the old

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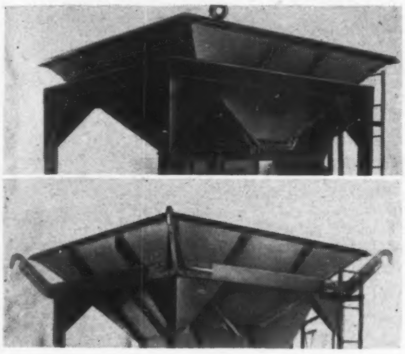
New Products
(Continued from Page 214)

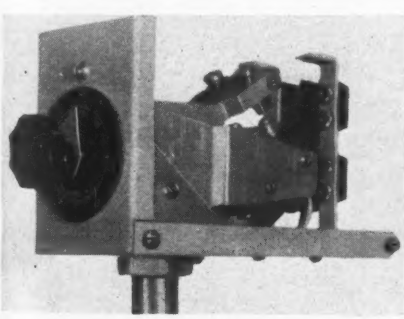
system of four hooks at each corner requiring the use of a sling.



Eye bolt unit for handling by crane (top) which takes the place of the four hooks shown on the unit at the bottom.

Temperature Limit Switch

Burling Instrument Co., Newark, N. J., announce a temperature limit switch available as a "one switch," "two switch" or three switch model. Among its features is the fact that this switch has but one lightweight moving part. Switch incorporates a corrosion and heat resisting tube; dial



Temperature control switch.

pointer for easy setting; and locking screws lock temperature setting.

Portable Gas Determinator

Harry W. Dietert Co., Detroit, has developed a portable determinator for the rapid determination of the gas pressure created by molding sand or cores. A sand or core specimen, 1⅛-in. by 3-in., is attached to the stem of the determinator. The specimen is then immersed in molten

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New Products

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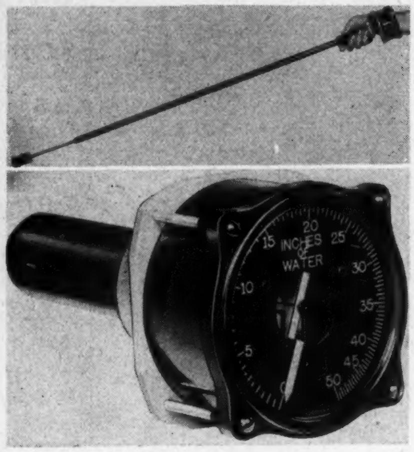
metal. The pressure of the gas envelope created by the specimen is



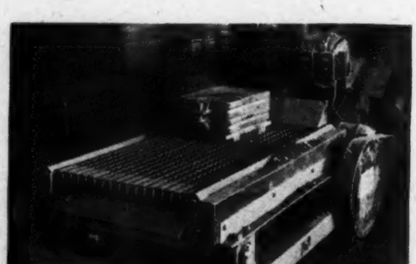
Top — Portable gas determinator which is used in determining gas pressure created by molding sand and cores. Bottom—Gage used in connection with the instrument.

shown on the gage of the determinator.

This instrument makes it possible to measure the pressure of the mold metal interface gas envelope by a very practical method that simulates mold conditions.

Shakeout

Royer Foundry & Machine Co., Kingston, Pa., has designed a shakeout that operates with a fast-positive walking beam action, with the result that flasks, bands, castings, etc., are conveyed off one end onto a belt or pan conveyor, without need of an auxiliary feeder. During operation only the walking beams move, while the remainder of the unit remains stationary. No vibration is



Foundry shakeout with a walking beam action.

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New Products
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transmitted to the structure. Sand cannot arch or ride on top, but quickly falls through the interstices between the stationary grids and the walking beams. Unit operates flat and requires low horsepower.

Safety Hook

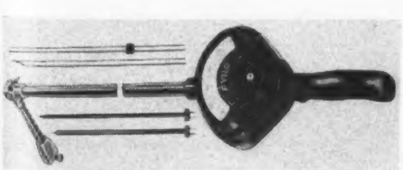
American Chain Ladder Co., New York, has designed a safety hook for the many hoist and loading problems encountered in the foundry. Tests show that the hook will tolerate loads exceeding 25,000 lb. Self-mousing action prevents hook straightening and load slipping.

Vibration Dampener

Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J., is producing a vibration dampener bushing for use with Manhattan wheels for portable grinders.

Pyrometer

The Pyrometer Instrument Co., 103 Lafayette St., New York 13, announce a pyrometer designed for the non-ferrous foundry industry. The pyrometer includes a large 4¾-in. indicator with a 4-in. direct reading scale calibrated from 0-1500° F. or 0-2500° F. or equivalent Centigrade. Two models with overall lengths of 27-in. and 43-in. are manufactured, both having a special designed swivel 8-in. from the connector block which permits the use of the pyrometer at any angle.



Immersion pyrometer especially designed for the non-ferrous foundry.

Swivel is equipped with toothed notches, thus preventing it from working loose during operation. Can be used with "bare metal" and "protected" type thermocouples, both being instantly interchangeable.

New Literature

Dow Corning Corp., Midland, Mich., has started to publish a series of pamphlets entitled "Silastic Facts." Copies are available upon request.

Bulletin No. 6878, published by Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J., describes a vibration dampener bushing for portable grinders. Bulletin may be obtained from the Abrasive Wheel Department.

The Bristol Co., Waterbury, Conn., has announced a new bulletin, No. pH1302, describing its line of pH Control Instruments. Copies may be obtained from The Bristol Co.

Castle Films, Inc., 30 Rockefeller Plaza, New York, has published a catalog fully describing available educational and training films. The listing includes both motion picture and filmstrips.

A postwar general catalog entitled "Specification Index for Bristol Instruments" has been published by The Bristol Co., Waterbury, Conn. The catalog, No. W1800, contains twenty-four pages of information on automatic controlling, recording, and indicating instruments.

Catalog No. 4 published by Arklay S. Richards Co., Inc., 72 Winchester St., Newton Highlands 61, Mass., listing a complete line of standardized industrial thermocouples, their parts, assemblies and accessories, is now available upon request from the above concern.

A circular describing an automatic flow regulator is available by request from Waterman Engineering Co., 721 Custer Ave., Evanston, Ill.

The Chemical Publishing Co., 26 Court St., Brooklyn 2, has issued a new catalog listing technical books, including those of very recent date, on such subjects as science, technology, medicine, engineering, metals and drugs. In accordance with the requests of technical and scientific workers and librarians, pub-

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New Literature
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lication date, price, number of pages, detailed description and full table of contents are included.

Copies of the catalog are available upon request at no charge.

"Fluxuations," booklet No. 14, published by Foundry Services, Inc., 280 Madison Ave., New York, is now available free of charge by writing the above company.

Metal Carbides Corp., Youngstown, Ohio, announces publication of a new 35-page die and wear part Catalogue No. 46-WP, containing full information, prices and particulars on tipped centerless grinder blades, wire and tube dies, sheet metal dies, extrusion and shape dies, bushings, gages, centers, bar stock, etc.

Specifications of various vanadium casting steels are detailed in a 24-page booklet issued by Vanadium Corp. of America, 420 Lexington Ave., New York. Examples of applications of these alloys are given; and sections relating to such aspects as nitriding and heat treatment are included.

A circular issued by Resinous Products & Chemical Co., Philadelphia, describes Uformite 580, a newly developed urea-formaldehyde resin designed to improve the properties of core sands for aluminum and magnesium castings.

Wheelco Instruments Co., Chicago 7, presents 32 pages of information on selection of proper thermocouples and accessories, in Bulletin No. S2-6.

Conversion factors and miscellaneous engineering data are contained in a 78-page handbook issued by Pesco Products Co., 11610 Euclid Ave., Cleveland 6.

American Foundry Equipment Co., Mishawaka, Ind., supplies information on abrasive air pressure cleaning and accessories, and rod-straightening machinery, in a 24-page booklet, Catalog No. 40.